Leo Simpson and Greg Swain present...

SILICON CHIP

$3.50 JANUARY 1988

AUSTRALIA'S NEW ELECTRONICS MAGAZINE

ERVICING — HIFI — AMATEUR RADIO — PROJECTS

rojects to build:

- igh-performance UHF antenna
- ual tracking power supply
- imple shortwave antenna
- ustom ringer for phones

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- rand Prix hifi awards: he winners
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fi review: arantz's super ew CD-94 CD player

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Regular column by Neville Williams

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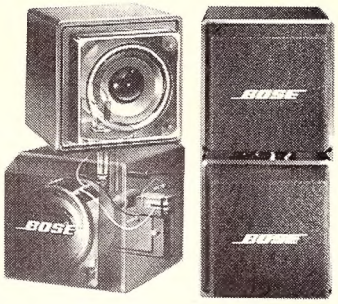
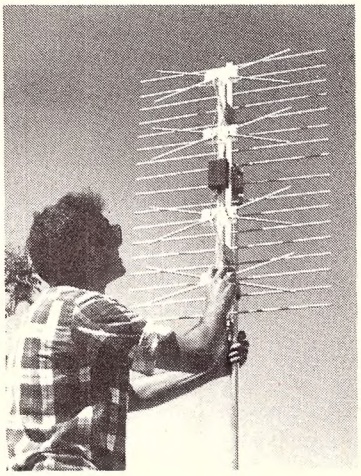
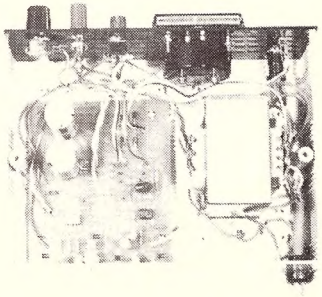


WHAT WERE the best hifi products for 1987? We name the winners of the 1987 CESA Grand Prix hifi awards on page 12.



IF YOU CAN do basic metalwork you can build this high-performance UHF antenna. It's a four-bay bow-tie design to cut down on interference and ghosting. Details page 14.



HERE'S THE ideal power supply for your workbench. This is a dual tracking design giving up to ±18.5V, and features voltage metering and short circuit protection. Turn to page 57.

SILICON CHIP

Publisher & Editor-in-Chief
Leo Simpson, B.Bus.

Editor
Greg Swain, B.Sc.(Hons.)

Technical Staff
John Clarke, B.E.(Elec.)
Robert Flynn

Regular Contributors
Neville Williams, FIREE, VK2XV
Bryan Maher, M.E. B.Sc.
Jim Yalden, VK2YGY
Garry Cratt, VK2YBX
Jim Lawler, MTETIA

Photography
Bob Donaldson

Editorial Advisory Panel
Philip Watson, MIREE, VK2ZPW
Norman Marks
Steve Payor, B.Sc., B.E.

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PUBLISHER'S LETTER

There's a UHF antenna in your future

Some time ago we planned to publish a four-bay bow-tie UHF antenna. We thought it would be quite a popular project since more and more viewers, even in the country, are now being serviced with UHF television broadcasts. The bow-tie array we are publishing this month has a number of desirable advantages over the more familiar long Yagis used for UHF. First, it covers both UHF bands and it has better discrimination against "aircraft flutter". With those thoughts in mind, we were quite pleased to be going to press with this antenna as featured in our article.

And that would probably have been the end of the story as far as our January issue was concerned. However, just as we were going to press, the Department of Transport and Communications issued stage one of a timetable for television channel changes from the VHF to the UHF bands. This is the long awaited announcement of the Department's plan to move television stations from the FM band, so that more FM stations can go on the air. Most of the displaced TV stations will have to move to the UHF (ultra high frequency) bands.

The timetable will mean far reaching changes for millions of people around Australia. Whereas most people up till now have not felt a pressing need to install a UHF antenna, even though some UHF services have been available, they will now have to do so. It will be mandatory, if they wish to continue watching the same programs.

Three television channels are in the FM band, 88 to 108MHz: channels 3, 4 and 5. As well, channel 5A will also be moved upwards. And a number of translator services occupying channels elsewhere in the VHF (very high frequency) bands will also move into the UHF bands to make way for some of the stations moved from the FM bands.

In stage one of the timetable just released, 15 TV stations and three translators will be moved from channels 3, 4, 5 and 5A. These moves will be accomplished by late 1990. Stage 2, for channel changes after 1990, will be announced in the next few months. We'll publish full details of the changes as they become available.

The changes have been decided upon after a long period of consultation with all parties in the TV broadcast industry. In the short term, they will cause some disruption while viewers slowly make the necessary adaptations. In the long run, we'll have a lot more FM stations which will be all to the good.

But sooner or later, many more people will be watching UHF TV broadcasts. Which makes our UHF bow-tie array rather timely, doesn't it?

Leo Simpson

MAILBAG

SILICON CHIP,
PO Box 139,
Collaroy Beach 2097.

A winner

I have just read the first issue of SILICON CHIP and you have an absolute winner. I cannot remember the last time I picked up an electronics magazine that had so much meaty editorial and project content. It is also pleasing to see that you have assembled a great team of contributors. It has been a long time since I actually looked forward to the next issue of an electronics magazine.

Gary Johnston
Managing Director
Jaycar Pty Ltd

Congratulations

Our hearty congratulations on the birth of your great new magazine. The high standard of both features and construction projects looks a winner. A few years ago the ranks electronics enthusiasts were decimated by defections to the personal computer phenomenon. I'll bet 90% of them have now found personal computers pretty droll. SILICON CHIP should be just the ticket to entice the hackers back to the world's most interesting hobby — electronics.

Jack O'Donnell
Managing Director
Altronic Distributors Pty Ltd

Delighted with format

Congratulations on your exciting new venture. As a long time enthusiast and previous subscriber to another electronics magazine, I was delighted with the format and content of the first issue of SILICON CHIP and wish you the best of luck for its success.

It was a pleasure to see some simple, cheap yet extremely useful projects which other magazines have been lacking in recent times (namely the Capacitance Adaptor for DMMs and the Off-hook Telephone Indicator, both of which I'll be building). Hope you'll keep up the excellent standard.

George Mangos
Maroubra, NSW

Likes steam

As a regular peruser of newsagents' shelves for magazines of various kinds, and a regular reader of various Australian electronics magazines, I was impressed with your first issue. It contained a good variety of articles, without the sanctimonious suggestion that everything therein (steam engines, for instance) was intrinsically tied up with "state-of-the-art" electronics. Congratulations.

T. Graetz
Walla Walla, NSW

Does not like steam

I have just purchased and read your first copy of SILICON CHIP. On the whole it appears to be a good attempt to breathe some life back into the electronics magazine scene in Australia.

My definition of an electronics magazine is one which introduces the reader, both beginner and experienced, to the technical aspects of electronics. These are to include explanations of new technologies, processes, design techniques and construction projects where possible to help reinforce the concept.

I am particularly interested in getting involved in amateur radio and I hope that your section will provide a good deal of information along with projects.

Too often these days, it appears to me, many magazines are overburdened with vaguely related topics. Just because its got a processor does not necessarily make it interesting. Therefore, I cannot condone your feature on electric railways or any similar articles you may have planned. An article on the devolopment and operation of electric motors would have been more relevant.

How your particular publication develops will be up to yourselves and your contributors but I wish you all the best of luck on your venture.

L. Iemi
Bentley, WA

Safer solution to M.E.N. hazard

I was very interested in your article "Your House Wiring Could Kill You" (November 1987). The MEN system has concerned me for many years, since introduction, due to the reasons outlined in your article.

I wrote to a number of authorities several years ago, stressing the inherent dangers of the system, to no avail. The bottom line was: "It is the consumer's responsibility to ensure his electrical installation is maintained in a safe condition."

Hands up who has done *that* in the last two years!

I have since debated this issue with electricians who genuinely understand the problem (there are very few who do) and they argue that two earths must provide better protection than one. While this may be true, it is also true that the consumer will be unaware when one of the earth connections becomes faulty. This condition could exist for several years.

The real problem occurs when the other connection becomes faulty or is disconnected by a tradesman (electrican or plumber). That's when *every* three-conductor appliance in the premises will become live at 240VAC above earth! Worse still, if the neutral is faulty and a plumber disconnects your incoming water pipe, all your taps will be live in addition to your appliances.

How often is that likely to occur you ask?

I firmly believe there have been at least five deaths in Queensland alone in the past several years that were directly attributable to the above condition. Newspaper reports say the deaths were due to an electrical fault.

Your article suggested that consumers could buy "clamp-on meters" and check their own installation. I do not believe people will go to this trouble, technical or not. There is a safer solution:

(1) Convert all premises back to the "Direct Earth" system; and

(2) Earth all neutral wires at suitable intervals at street power poles.

This will give the advantages of the MEN system without the safety hazards to consumers.

M. McDonald
Wynnum, Qld

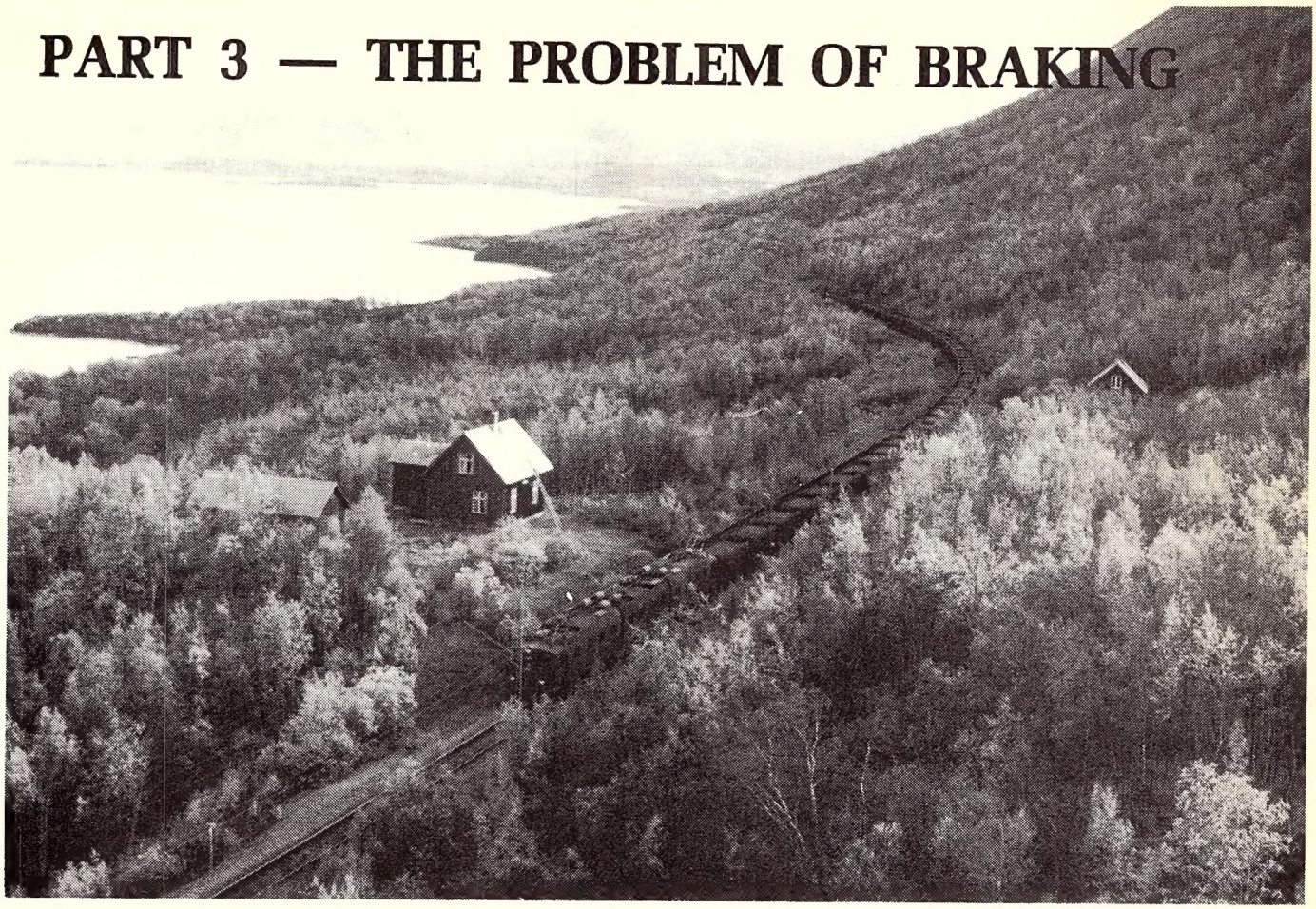
Jumper lead solution

I like your new magazine. It looks good and the content is excellent. Good also to see the Veroboard alternatives for projects. I don't usually buy kits and have no enthusiasm for making boards, hence usually have to do the conversion myself.

I have two comments on your article entitled "Your House Wiring Could Kill You". You say the wiring can develop a dangerous fault. Actually the danger only arises when

continued on page 70

PART 3 — THE PROBLEM OF BRAKING



THE EVOLUTION OF ELECTRIC RAILWAYS

While early railway development in England and America is well documented, much pioneering work was also done in Europe, particularly in France, Germany and Sweden.

By BRYAN MAHER

Sweden did some impressive development for they were in the railway business quite early, having used horse-drawn mine railways as early as 1798. The first steam locomotive built in Sweden was named the "Forstlingen" and began service on a private line from Orebro to Nora in March 1856. The Government responded with the opening of a line from Goteborg to Jonsered and another from Malmo to Lund, the first segments of their future National Network, in December of the same year.

Within six years the railway crossed their country from Stockholm to Goteborg and by 1892 they had in operation the world's first International Train Ferry, connecting Helsingborg in Sweden with Helsingor in Denmark.

In 1885 to 1902 they built the first railway within the Arctic Circle, the Lapland Railway, to transport iron ore from Kiruna to Norway's ice-free seaport Narvik. This railway was electrified in 1915.

Extended to the Swedish port Lulea on the Gulf of Bothnia in 1903, the whole 490-kilometre length was fully electrified by 1922. This world-first initiative in the development of low frequency alternating current traction

At left, a view of Sweden's Lapland Railway in mid-summer. This line runs within the Arctic Circle but carries 38 trains per day in each direction. (Bryan Maher photo).

systems initially used a 15kV 15Hz supply generated specifically for traction in low speed water-driven alternators at the Porjus Power Station and transmitted via 80kV single phase power lines. The motors used are series commutator motors.

The reason for the low frequency supply is that on higher frequencies like 50Hz the interpoles do not effectively cancel the armature magnetic field reaction on the main magnetic field, leading to severe arcing between commutators and brushes.

The permanent summer snowline in such northern climes is a mere 1000 metres above sea level. Since about half the line's length is above 500 metres elevation, the track is only free of snow during midsummer. Therefore, the electrical designers decided to house all trackside 80kV/15kV transformers within large brick buildings for protection. But this plan came slightly unstuck when the electrical workers had the transformers temporally installed and working out in the open while the bricklayers were still at it.

As winter approached, all work necessarily ceased but the transformers and electrical gear performed beautifully all winter, even in blizzard conditions. The cold air gave better cooling and allowed the transformers some overload rating so the engineers decided to leave them where they were.

Keeping in mind the low frequency used, transformer cores and hence complete transformers are considerably larger than similar 50Hz types so the now unwanted brick buildings had been built to generous proportions. But what use could be made of them now? Eventually, these strong brick structures were put to good use as the roomiest passenger waiting rooms on the system.

As well as being a lesson in international cooperation, as locomotives of both countries (Sweden and Denmark) share the work, this line is unusual for Europe as ore trains of 5500 tonnes are commonly hauled by Dm class 4.8 megawatt (6400 horsepower) or Dm3 class 7.2 megawatt (9400 horsepower) locomotives. Perhaps you may find it difficult, gentle reader, to picture such an Arctic installation as a busy thoroughfare but in fact the average traffic is 38 trains per day in each direction — six passenger and 32 ore trains. More than 30 million tonnes of iron ore are shifted to Narvik annually.

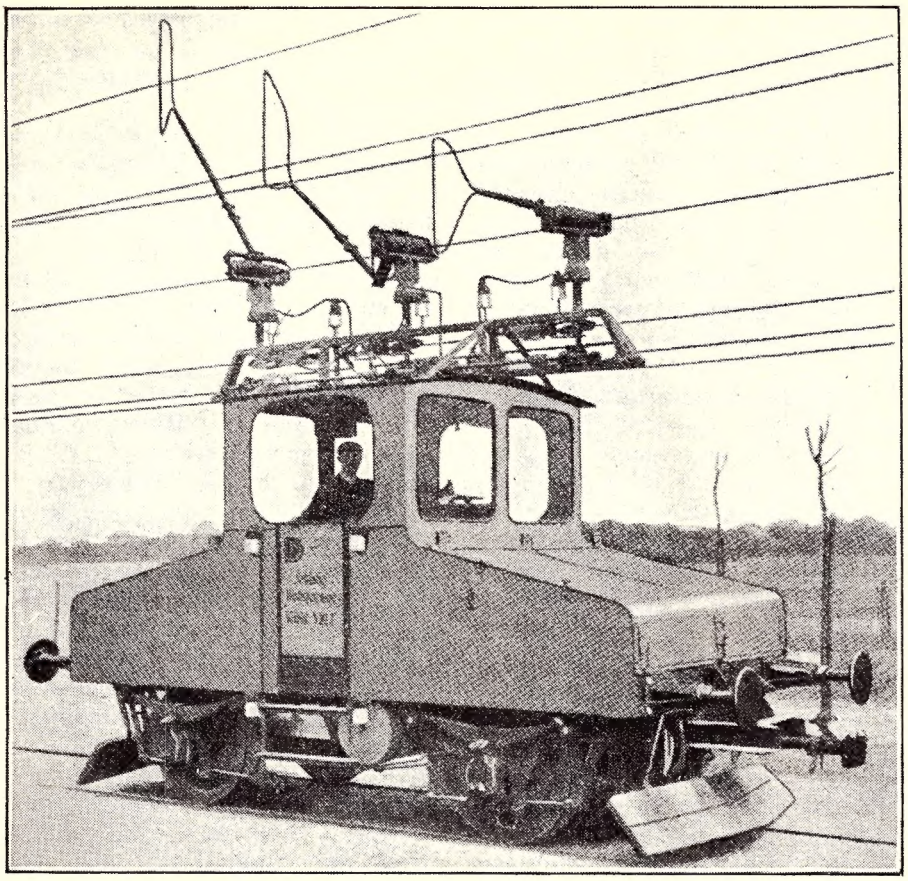
When other Swedish lines were electrified, frequency converters were used to derive 16.666Hz single phase traction supply at 15kV from the three phase national grid 50Hz system. This method eventually replaced the 15Hz supply on the Lapland line also. By 1942 the world's longest electric train journey was in Sweden, a distance of 2022 kilometres.

Braking

In the 1830's it became quite apparent to the railway world that a moving train is very hard to stop and the early increases in locomotive power and train weight only increased the problem. Originally in England, hand operated brakes were fitted to each wagon and a guard was appointed to run along beside the train and set each truck's brakes as the train slowly rolled over the top of a hill.

You may find it hard to believe, but this method of braking was still in use on a few privately owned coal lines in the Newcastle areas as late as the 1960s. Increases in train speed in the 1840s soon put this method in the "too hard" category. American railroads responded by

This two-axle electric locomotive was made by Messrs Fowler & Co, of Leeds, England at the turn of the century. It was intended for use on short lines. Electrical pickup was via trolley wheel. (Norm Marks photo).



Built in 1901 by Messrs Siemens & Halske, of Berlin, Germany, this experimental loco used 50Hz three-phase AC at 10,000 volts. On board transformers stepped the voltage down to 750VAC. Just imagine the complications of the overhead wiring at points. (Norm Marks photo).

fitting a walkway along the top of the roof of every wagon. At the end of each wagon's walkway was a handwheel to apply the brakes.

Brakemen had to run the length of the speeding train to apply the brakes by turning each wagon's handwheel. When some handwheels were found hard to turn, each man was supplied with a heavy wooden club to assist. Tales of the Roaring West showed that these brakemen's clubs were useful in a brawl too!

With longer trains up to four brakemen per train were employed, two riding in the brakevan and two riding on the engine. If two large locomotives were used double-headed, a train crew could be considerable, with a driver and two firemen to each loco, four brakemen and a conductor, eleven men in all.

Such a headcount can only reflect the low wages and long working hours of those days. Can you appreciate their tough working conditions descending the mountains in a winter snowstorm?

To further assist in stopping trains the caboose (guard's van) was made large and heavy and equipped with a powerful handbrake operated by the conductor from within. Coal trains in the Newcastle area up to the 1960s still used the same idea.

Vacuum brakes

England, with more finesse, invented a vacuum operated brake system with vacuum pipe, hoses and hose couplings running the length of the train. Brakes on each wagon were pulled on by a spring and simultaneously held off by vacuum in a piston and cylinder. The train driver set the steam-driven vacuum pump in operation which evacuated the "train line" (ie, the pipe, hoses and all brake cylinders), pulling all truck and loco brakes off. This was the running condition.

To stop his train, a driver simply turned a valve to allow some air into the "train line" and all truck brake cylinders let go partially or fully so the brakes were pulled on by the brake-springs. The nice part was that should a train coupling break and the train become parted, the hose couplings automatically uncoupled, allowing air into the lines of both parts of the train and all were brought to a safe stop.

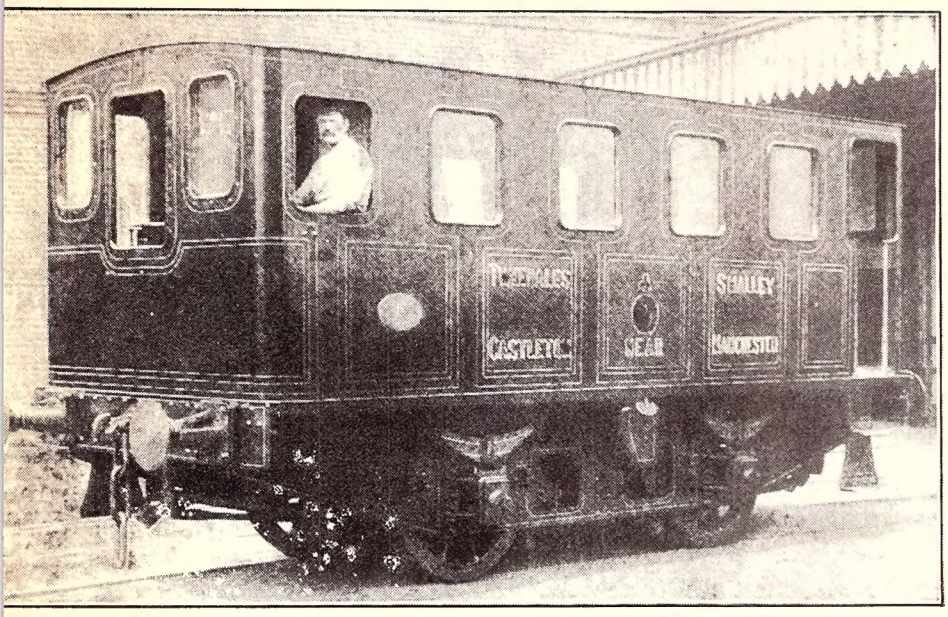
This method was used for years in Britain but trouble came when trains became heavier and faster still. Other countries experienced the same problems as they were building lines up and down mountains. There is a limit to the pull that can be exerted by a vacuum cylinder as it can only have one atmosphere pressure or about 15 psi acting on the piston. That limits the useable strength of the brake-spring and hence limits the braking force that can be applied. Some way of using higher pressures was clearly needed.

Westinghouse air brakes

That's where the Americans came into the picture. Inventive readers across the country can be heard mumbling something like "So what's the problem ? Why not just apply compressed air to the piston, any pressure you like to make it, instead of vacuum? Use 100 psi or 200 psi or whatever is necessary to pull off a more powerful brake-spring?"

Such an idea would give protection in case of a train coupling breaking. Furthermore, a wagon parked on a siding would perforce have its brakes on, and a handwheel and gearing could be used to pull the brakes off a parked truck when we want to move it for loading. The idea has in fact been used for short trains; you could call it a "straight air" system.

But the catch comes with a long train, say a kilometre long with 100 wagons, each with its brake cylinder full of air. That's a large quantity of air to be moved a long distance to the engine before the brakes are applied, and the brakes would be firmly "on" in the front wagons long before the air had travelled from the back of the train where the brakes are still "off" This would result in a nasty



Pictured is a battery-operated loco used on the Lancashire and Yorkshire Railway. The loco weighed 22 tonnes and was capable of pulling loads up to 120 tonnes. (Norm Marks photo).

"concertina" effect every time the driver uses his brake control.

The Westinghouse organization of the USA patented a system wherein each wagon carries its own high pressure air reservoir and a 3-way air valve called the "triple valve". Brakes are applied by air pressure, not by spring, when the triple valve opens a path from the wagon's air reservoir to the brake cylinder. Brakes are released when the triple valve opens a path from the brake cylinder to atmosphere, letting the air escape, and simultaneously closing off the wagon's air reservoir.

The lost air from the wagon's reservoir must be replaced for the next brake application. While brakes are not being used the triple valve opens a path from the train air pipe to the wagon's air reservoir, allowing the air compressor on the locomotive to refill all wagon air reservoirs. This pumping-up process usually takes some time but that is acceptable if the system is used intelligently.

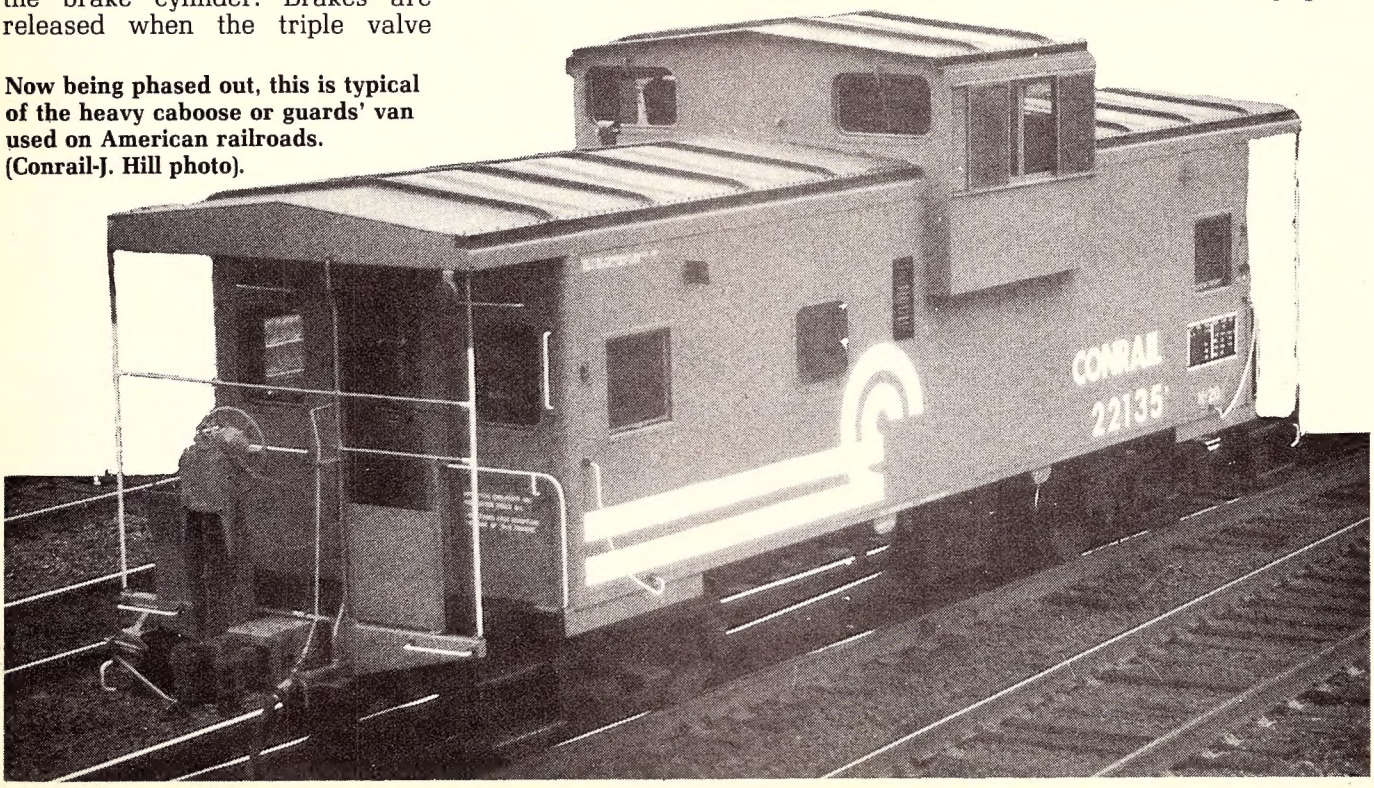
"And just how?" you ask "does that clever triple valve know when it is supposed to change its function as aforesaid?" Yes it is a clever little valve indeed. Its function is dictated by the difference in the pressure between the wagon's reservoir and the "train line". So the loco driver controls the triple valves and thereby the brakes by letting air out of the train line or allowing his compressor to pump the line back up again.

The above story is a simplified explanation but it does show that full brakes can be applied by emptying to atmosphere only the air contained in the train line pipe. This is not a great quantity of air so it can be done fairly quickly. And if coupling breaks the train, full brakes are automatically applied to all train sections.

Furthermore the guard or conductor can apply emergency brakes to the whole train, including the locomotive, by opening a simple on-off valve mounted in his guard's van or caboose emptying the air out

continued on page 74

Now being phased out, this is typical of the heavy caboose or guards' van used on American railroads. (Conrail-J. Hill photo).



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WHY BUILD YOUR OWN COMPUTER?

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(2) Imagine being able to say 'I built it myself!'

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Business People: now the computer you've always wanted at work can be the one you have. And with the money you'll save, there'll be enough left over for another one at home!
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(3) We've made it so affordable!

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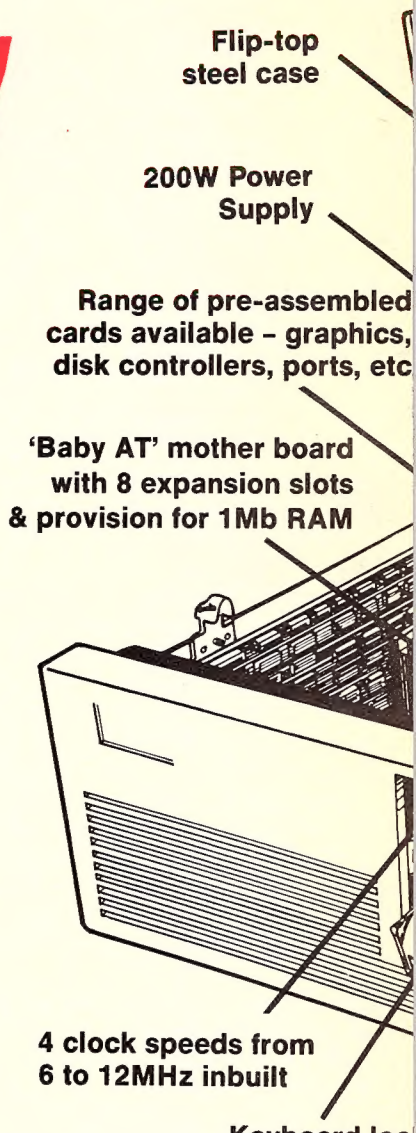
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Real time clock on board (battery b/
8 Input/Output Slots
(6 with 62 and 36 pin connector, 2 with 62 only)
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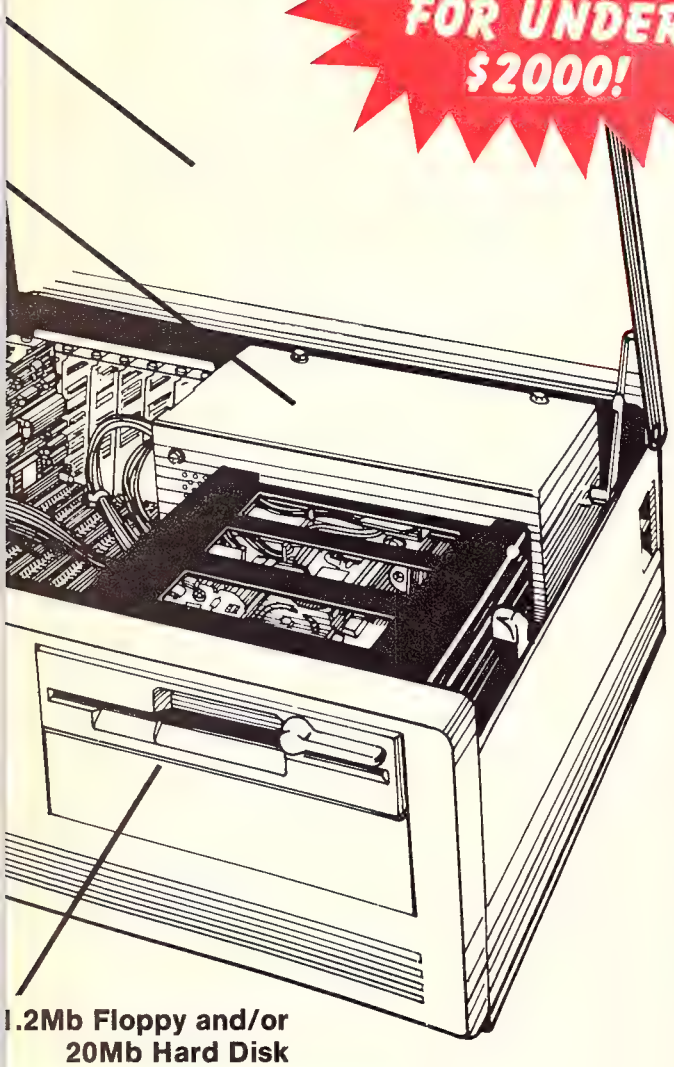

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SPECIFICATIONS

Hard/Floppy Disk Controller:
Controls 1 or 2 hard disks
Ind. standard ST-506/ST-412 Interface
Up to 2048 cylinders
Up to 16 read/write heads
Data Transfer rate 5Mb/s

Controls 1 or 2 floppy disk drives
Interface similar to FD-55F minifloppy
Double density 320/360Kb or 160/180kb
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Rated to work up to 12MHz

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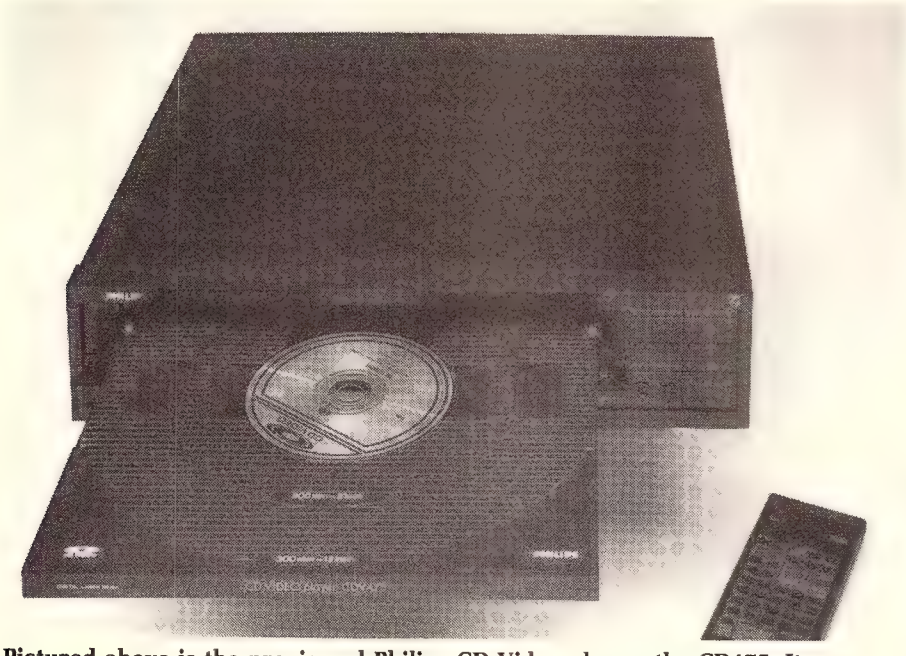
NEWS & VIEWS



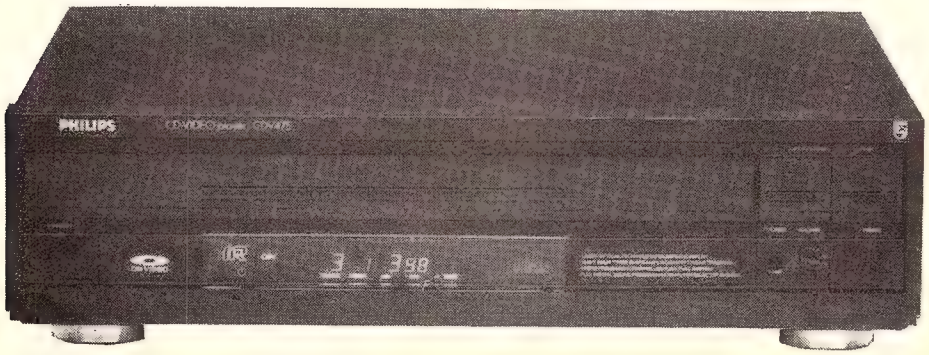
Pictured above is the previewed Philips CD Video player, the CD475. It can play 12cm, 20cm and 30cm video discs. Note the massive disc drawer.

Philips previews compact disc video

Just when you thought things were fairly quiet on the technological front, Philips have stirred the pot again. Late last year Philips previewed CD Video — compact discs with video. They weren't just video stills either, they were the full bit — moving colour pictures, every bit as good as from the current VHS HQ VCRs. And they have the same high quality compact disc sound.

"Alright," you are saying,"that's pretty radical but I can accept it. So what?" Well, CD video discs will not just be on the familiar 12cm discs we have become used to; they will also be in 20 and 30cm versions too. The 12cm version will contain six minutes of video and music plus another 20 minutes of music only. And it can be played on any CD player, video or not. It will be known as the video "single".

The 20cm version of the disc will contain about 40 minutes of music and video while the 30cm version will contain about two hours of music and video. In a throwback to the vinyl record days, they will be known as "extended play" and "long play" discs.



With the disc drawer closed, the CD475 looks very much like a normal CD player. No release date has yet been set, nor is there any indication of price.

AM stereo for ABC Darwin

Radio 8DR in Darwin has begun transmitting in AM stereo and is the most recent of the ABC's metropolitan stations to have this facility.

We were interested to read the following in a press release on the event. "Because AM stereo is a recent innovation, only late model

Have you taken all that in? The next bit is even more interesting. Philips have developed a player which plays all the CD video discs described above, plus normal compact discs, plus *all* optical video discs ever made. They demonstrated the machine, the Philips CD675, with a video disc released nine years ago!

This means the player can be used with interactive video discs. Naturally, the machine has perfect video stills and slow motion replays. Boggle, boggle.

At the time of writing, no info was available on the likely release date to the market of the discs or the players; nor was their any real indication of prices. We expect that release will probably be towards the end of this year.

New CD format gives recording facility

Philips and Sony, the co-developers of the compact disc, have agreed on specifications for a CD Write-Once system intended for professional use. The proposed write-once recorder will permit recording of data or audio information onto a blank write-once disc. The information can then be played back repeatedly, as for a normal compact disc or CD-ROM.

Data storage capacity will be essentially the same as for the existing CD-ROM; ie, a mind-blowing 600 megabytes.

radio receivers are capable of receiving and reproducing AM stereo, however all AM radio sets can still receive AM stereo broadcasts. Those sets without stereo capability will simply reproduce them in mono.

ABC listeners wanting stereo sound reproduction should first check that their radio sets have built-in AM stereo capability."

We wonder if ABC listeners will bother.

Australian hifi manufacturers band together

A group of Australian hifi manufacturers have formed an association to promote their products on local and overseas markets. It sounds like a good idea to us.

We hope they do a lot more than the majority of foreign-owned companies at present in the market. While some sectors of the hifi market are doing quite well, others are dying on their feet because of the lack of any promotion.

There is just one drawback to this promotional scheme; it will go under the dreadful logo, Ozfi. Will anyone take a product with an "Ozfi" label seriously?

1988 Field Day for Central Coast Amateur Radio Club

Come one, come all. All amateur radio operators, their families and anyone interested in amteur radio are invited to attend the 1988 Central Coast Radio Club Field Day to be held on Sunday, 21st February at the Gosford Showground.

If you're interested, put the date down in your diary. If you are a potential trade exhibitor, contact the Central Coast Amateur Radio Club, PO Box 238, Gosford, NSW 2250.

Philips gives James Bond the best

Advertising has leapt to new heights with the release of the latest James Bond film, "The Living Daylights". This is loaded with the usual improbable plot, improbable dialogue and improbable escapes and is a lot of fun.

The most unusual feature for us was the exposure of Philips products. This wasn't glaringly obvious you understand, and you could easily miss it if you weren't aware but we noted at least 12 instances where the Philips brand name or Philips products were featured. Some of the tasks to which Philips products were put to were a little unusual to say the least.

As far as we know though, James Bond's special keyring which is loaded with a number of techno-gimmicks, is not a standard Philips product. We doubt whether it would be approved for general sale.

Radio service for Japanese tourists

In case you didn't believe it, Australian companies are working harder to cater to tourists, particularly those from Japan. Commencing next month, there will be a special radio service aimed at Japanese tourists. Known as Travrad (Travellers' Radio), the service will be broadcast in Adelaide, Alice Springs, Brisbane, Cairns, Canberra, Darwin, Gold Coast, Melbourne, Perth and Sydney.

Broadcasts will be narrowband FM on about 151MHz from 6am to 10pm every day. The broadcasts will be picked up on fixed receivers in motels and hotels and on portables which will be available for hire at hotels and other tourist destinations.

The service will be operated by a new company, Fidelity Communications Corporation Ltd.

It will be a Japanese language service carrying news and info about tourist activities, Australian history, customs and lifestyle, music and human interest material.

Better throw another shrimp on the barbie, eh?

Cordless phone import ban

The Department of Transport and Communications has moved to prevent overseas travellers from bringing back cordless telephones into Australia.

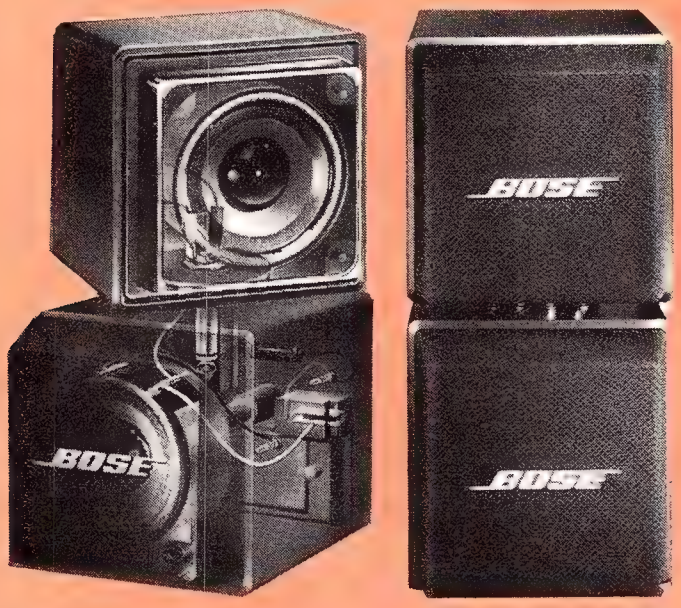
In a recent announcement, the Minister for Land Transport and Infrastructure, Mr Peter Duncan, said that all cordless phones brought into Australia are being impounded and must be tested before release, by the Department of Transport and Communications, by Telecom and by one of the Electricity Authorities. He noted that fees for this type of testing may exceed $1000 and there is no guarantee that any equipment will be approved for use.

Better knock that item off your overseas shopping list. Approved cordless phones will continue to be on sale in Australia.

Four-wheeled boats!

Now that OTC's automatic Seaphone service with direct dialling ship-to-shore has been introduced (see story this issue), how many cars are likely to be fitted with marine radios? That's a question the pundits are asking themselves as they compare the pros and cons of Telecom's cellular radio with Seaphone. With the much lower initial cost of Seaphone, it is probable that quite a few will be fitted to cars.

It seems that OTC's base radios do not ask the position of boats when they call in so they have no way of knowing whether the radio is fitted to a boat or car. There has been at least one instance of a Seaphone call for road service.



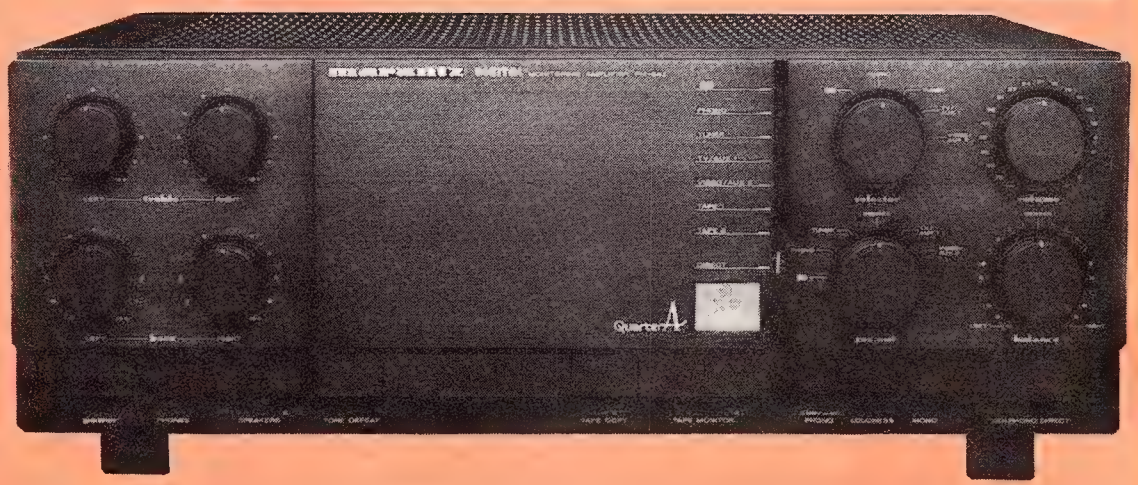
WINNER IN THE Technological Development category, the Bose Acoustimass system uses the very small stereo satellite speakers pictured above, which are only 19cm high and have magnetically shielded drivers, allowing them to placed near video monitors. The Acoustimass woofer module, pictured below, can be positioned anywhere in the room.

FOR A NUMBER of years now Sony has had a reputation for very fine tuners and this year they won out with their model ST-S444ESX. Its outstanding specification includes an ultimate signal-to-noise ratio of 96dB in mono and 91db in stereo. RRP is $893.

THE 1987 HIFI AWARDS

— THE WINNERS —

From a limited field of runners, this year's CESA Grand Prix hifi awards produced some interesting winners. Consistent performers like Marantz and Sony were there again, as was Yamaha, while Bose chalked up its first award.



BEST AMPLIFIER this year was the Marantz PM-64II which has comprehensive input control facilities, including video inputs and CD-direct, which bypasses the tone controls and other preamp circuitry. Power output is 100 watts RMS per channel and up to 300 watts (IHF music power) into 2-ohm loads. RRP is $1099.00.

YAMAHA HAS been one of the few Japanese loudspeaker manufacturers to really gain a reputation for its loudspeakers. This is not the first time it has won the CESA award for best loudspeaker. This very fine 3-way system, the NS-10000, uses carbon fibre technology in the woofer and beryllium for the tweeter and midrange domes. RRP is $13,000.00.

By LEO SIMPSON

The CESA Grand Prix hifi awards have been having a rough trot since their inception three years ago and each year has been marked by less entries as more hifi distributors retire from the field to lick their wounds and comtemplate an ever toughening market.

A surpise, but no surprise really, was that there were no entries at all in the turntable category. The Japanese have virtually abandoned the field altogether to chase after the burgeoning compact disc market. This, while millions of people around the world still have billions of records they wish to play.

Winner in the amplifier category was the Marantz PM-64II, making it two consecutive wins for this company. The PM-64II is a keenly priced model with plenty of power and facilities. Runner up was the powerful Perreaux PM2350 with 200 watts per channel.

No award was made in the receiver category, since it was only a two-horse race. Similarly, the judges decided not to make an award in the cassette deck category — it was a field of plodders but the racers of the day hadn't been entered.

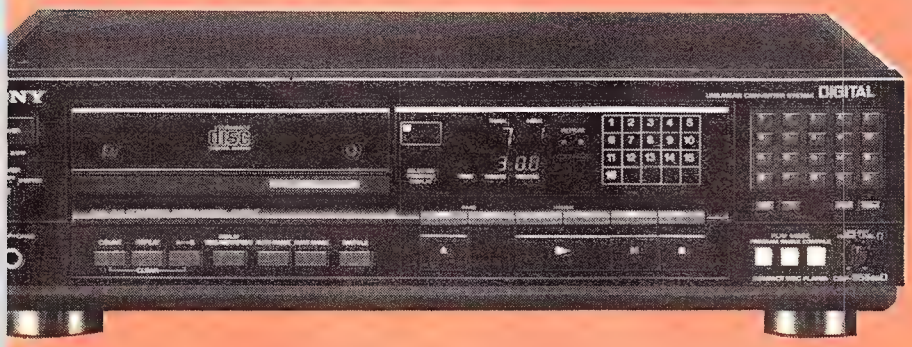
In spite of the large number of CD players on the market, there were only five entries in this category, from Marantz, JVC, Yamaha, Sharp and Sony. Sony was the winner, with their highly rated model CDP-555ESD.

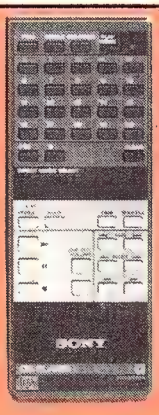
Sony also won the tuner category, with their ST-S444ESX model which has very high performance in its FM section.

The other two awards, for best loudspeaker and for technological development, were interesting because the respective winners were originally not entered in their ultimate award category. The Bose Acoustimass, a satellite-cum-superwoofer system was entered in the loudspeaker category but won the award for technological development.

And the Yamaha NS10000, which was entered in the category for technological development, won the prize for best loudspeaker.

Let's hope there are a lot more horses running next time.





SONY'S top-of-the-line CDP-555ESD CD player has every feature you could think of, including remote volume control. It can also be teamed with an optional linear D-A converter, the DAS-702ES, for even higher performance. RRP of the player on its own is $2299.00.

Build a four-bay bow-tie UHF antenna

By LEO SIMPSON
& BOB FLYNN

If you can do basic metalwork you can build this antenna. Your bill of materials will be around $25 and the finished antenna should give better performance than commercial UHF Yagi antennas costing up to a hundred dollars and more.

In Australia, on the UHF (ultra high frequency) TV bands, the Yagi antenna is king. UHF Yagis are now very familiar on Australian rooftops. They have a long boom, up to 1.8 metres or more, with many short elements arranged along it.

The Yagi design for UHF has many advantages. It is easy to mass produce, uses a modest amount of material, has relatively low windage (ie, force due to wind acting on it), good directional characteristics and good gain, depending on the number of elements.

The Yagi does have a number of drawbacks though. It must be made with considerable precision if it is to perform well, so it is not so easy for the enthusiast with basic metalworking facilities to build. It is also a no-compromise design in that it is not practical to design a Yagi which will cover both UHF bands, particularly if you want a modicum of gain. You can have band IV or band V but not both.

In Australia, by the way, UHF band IV covers channels 28 to 35, 526 to 582 Megahertz. UHF band V covers channels 39 to 69, 603 to 820MHz. Each channel occupies a 7MHz slot.

In Europe and other parts of the world, there are common alternatives to the Yagi design. One is a Yagi with a corner reflector, another is a bow-tie with corner reflector, while a third is the most common, the bow-tie array. This is essentially a dipole (shaped like a bow tie) with a plane reflector close behind it. Higher gain is obtained

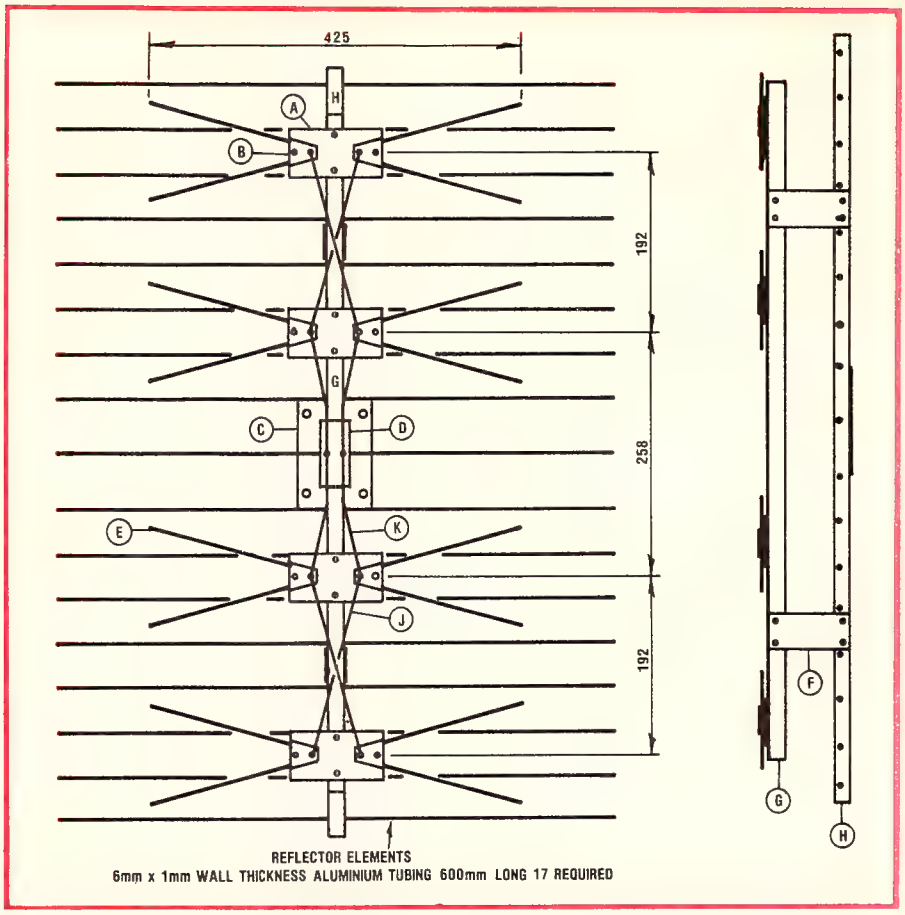
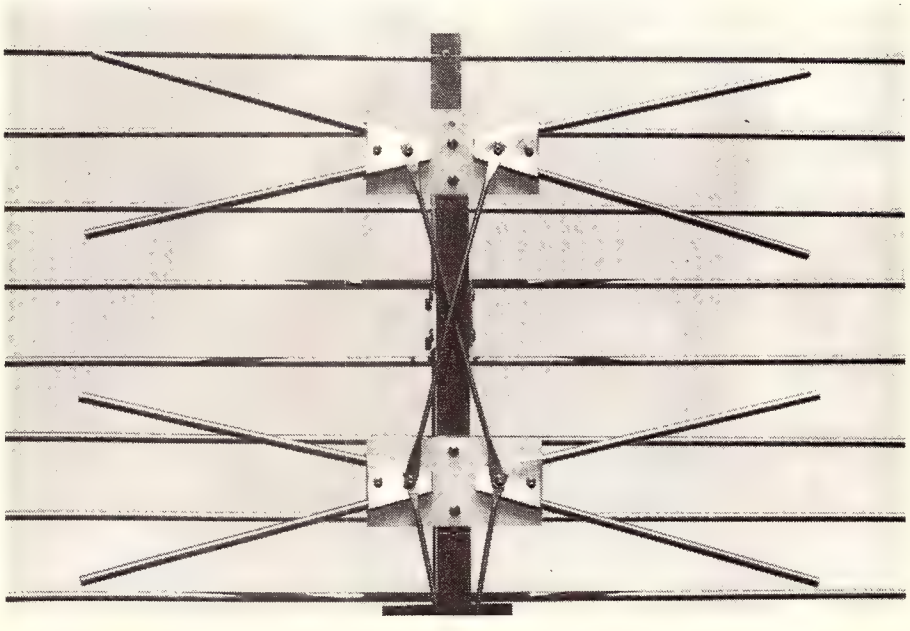


Fig.1: front and side elevation of the new UHF antenna. This diagram labels all the special hardware items that you have to make except for the reflector elements. Below is a close-up view of two of the dipole bays.



Thinking about building an antenna to pick up UHF TV in your area? This four-bay bow-tie array has high gain and covers UHF bands IV and V without modifications.

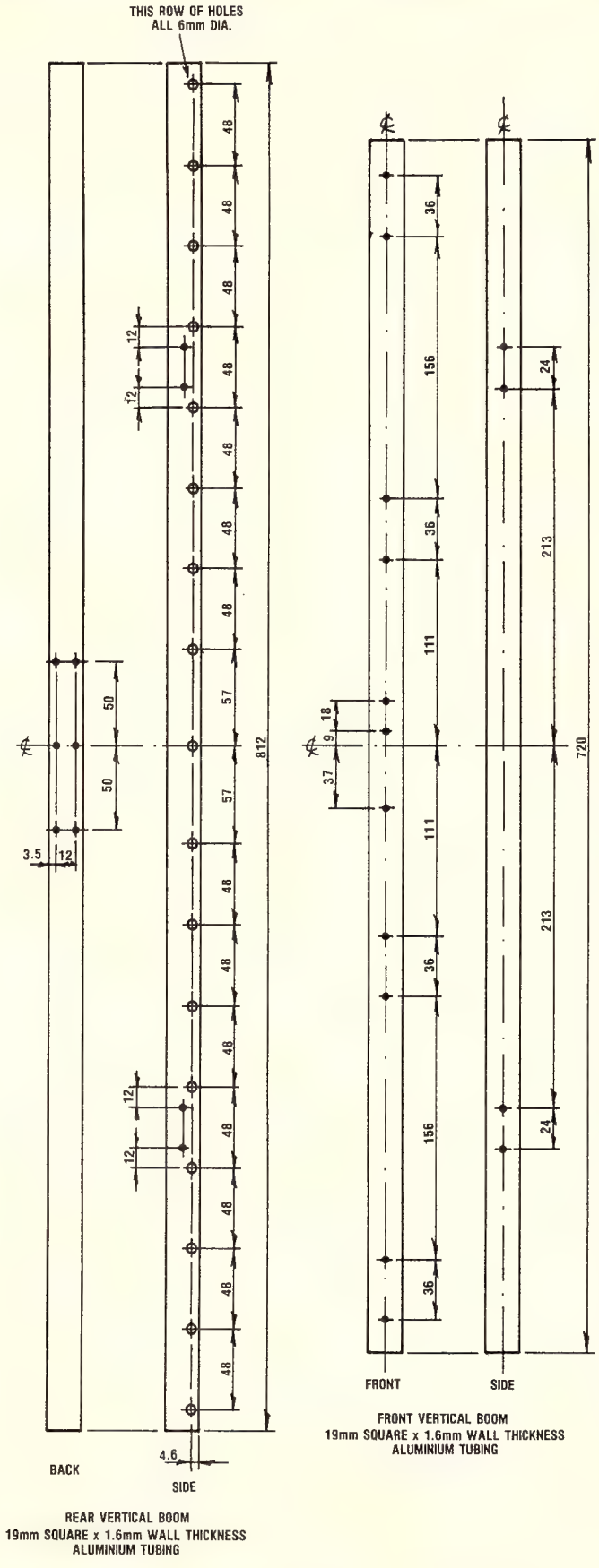


Fig.2: cut and drill the front and rear booms exactly as shown here.

by stacking bow ties, in either two-bay or four-bay arrays. The latter is the design we are presenting.

The four-bay bow-tie array antenna has a number of advantages over typical Yagis. First, it can cover both bands IV and V without modification. Second, it has better gain than all except the highest gain Yagis which may measure up to three metres long. Third, it has good front-to-back ratio and a much narrower acceptance angle, in both the vertical and horizontal planes.

(Note: the 18-element TC-18 from Hills is a combination of a long Yagi with a small corner reflector. The corner reflector gives it slightly higher gain and a narrower acceptance angle. For those who do not wish to build their own antenna, it

BILL OF MATERIALS

Antenna

1.6 metres of 19mm square aluminium tubing with 1.6mm wall thickness
13.8 metres of 6mm aluminium tubing, 1mm wall thickness
1.4 metres of 3mm dia. solid aluminium rod
270mm x 130mm x 1.6mm aluminium sheet
410mm x 50mm x 3mm thick Perspex
50 pop rivets (3mm x 6mm, aluminium mandrel); or
50 stainless steel self-tapping screws (see text)
2 U-bolts and clamps to suit mast
16 stainless steel screws, 3mm dia. x 16mm long, nuts and shakeproof washers

Balun Box

1 80mm x 52mm x 30mm plastic box
1 printed circuit board, SC2-1-0188
3 6BA x 12mm screws with nuts
2 6mm spacers
3 stainless steel self-tapping screws, 15mm long

Miscellaneous

75Ω semi-air spaced coax cable (Hills SSC32 or equivalent), plastic cable ties, silicon sealant, Delrin plugs (for square tubing)

is a good choice in fringe areas. It is available in Band IV and Band V versions).

The narrow acceptance angle of a four-bay bow-tie array is important, particularly if your location does not have a good line-of-sight to the transmitter and if you are often over-flown by aeroplanes. This combination of circumstances can lead to a phenomenon known as "aircraft flutter".

When this occurs, the signal reflected from the aircraft to your antenna can be stronger than the more direct signal received from the transmitter. This causes very strong ghosting on the screen and a slowly fluctuating vertical bar on the screen which is the ghost of the horizontal sync pulse.

The picture flutters because the plane is moving at high velocity relative to your antenna and so the path of the strong reflected signal is changing rapidly.

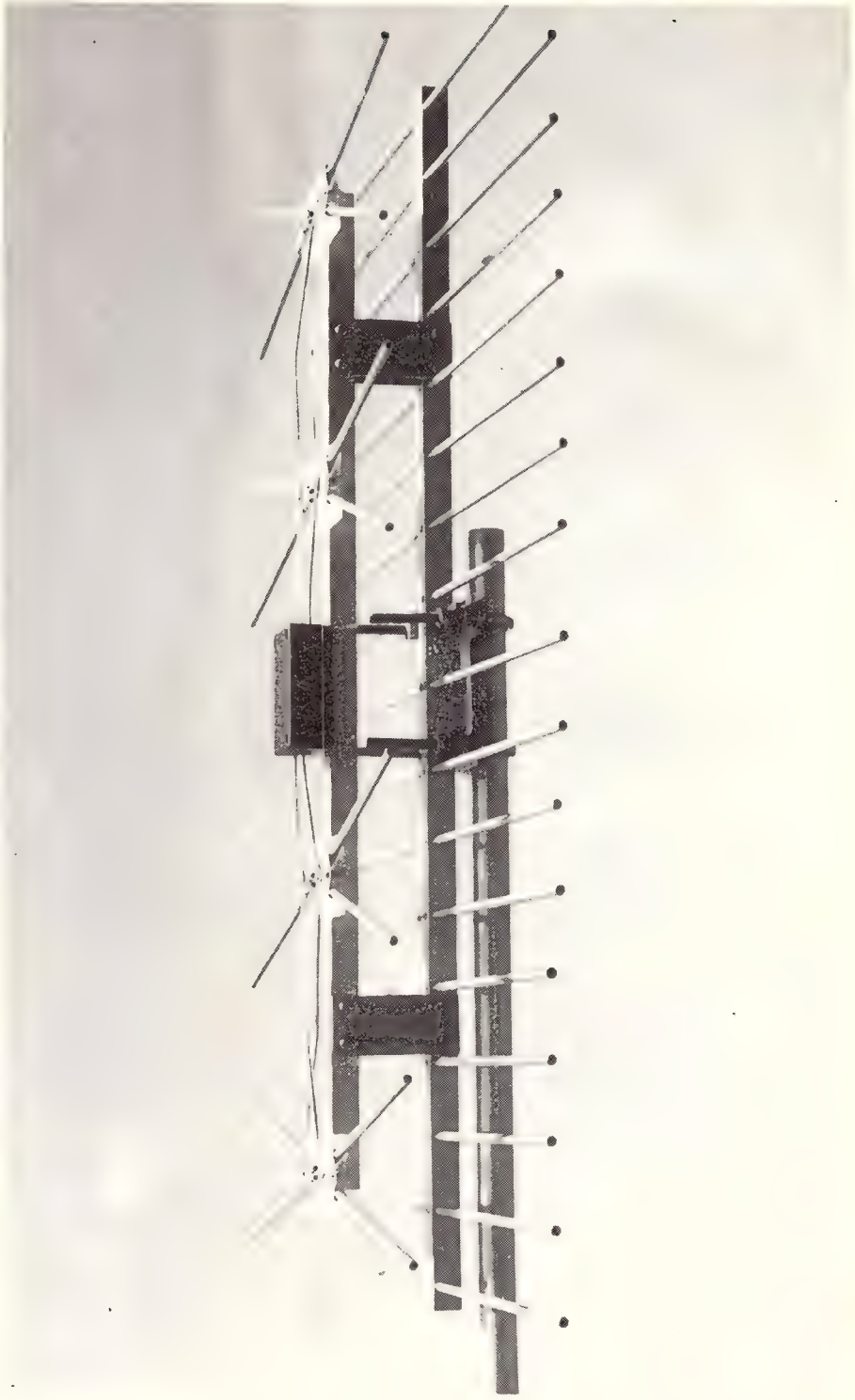
In severe cases, aircraft flutter can cause the picture to lose horizontal synchronisation.

Where the bow-tie array has a considerable advantage over the Yagi is that it has a much narrower vertical (and horizontal) acceptance. This is about half that for a Yagi of equivalent gain; ie, about 27° versus about 40°. This means that the bow-tie array will pick up much less reflected signal from high flying aeroplanes and therefore interference is much less.

Well, what about the disadvantages of the bow-tie array versus the Yagi. Yes, it does have some. First, because it is a vertical rather than horizontal array, it has considerably more windage. Second, there is probably more work in fabricating a do-it-yourself design such as this.

While we did not have equipment for measuring the absolute performance of the bow-tie array featured here, we were able to make a lot of direct comparisons with commercial UHF band IV and band V Yagi designs. These were essential to optimise the performance for both band IV and band V.

After a lot of trial and error, we are pleased to present a design which is very competitive with pre-



The front and rear booms are fastened together using four tie plates (see Fig.6). Bend the cross-coupled harness connectors slightly so that they do not touch each other.

sent commercially available Yagis and as noted above, it is notably less susceptible to "aircraft flutter".

Design features

Our bow-tie array is similar in appearance to a number of commercial designs which are available overseas. It is constructed mainly of 6mm aluminium tubing with the two vertical structural members (booms) being 19mm square tubing. The four dipoles are effectively vestigial bow-ties, being Vees made of tubing rather than

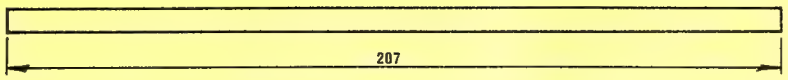


Fig.3: the 16 dipole elements are all made from 6mm aluminium tubing. Cut the dipoles to a length of 207mm.

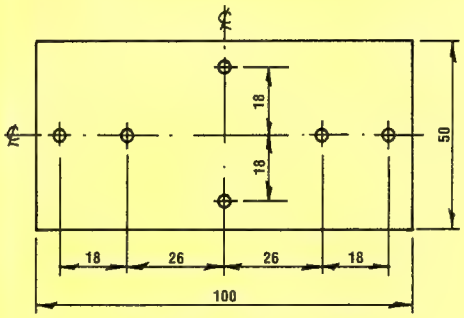
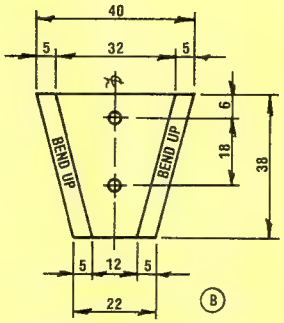


Fig.4: either 3mm thick Perspex or clear Lexan can be used for the dipole carriers (four required).



DIPOLE MOUNTING CLIPS
1.6mm ALUMINIUM 8 REQUIRED

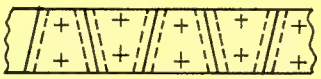
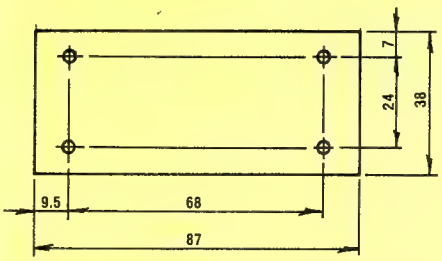


Fig.5: the eight dipole clips are cut out using tin snips and then bent up in a vice.



◀ Fig.6: cut and drill the four aluminium tie plates as shown here. These tie the front and rear booms together.

triangular pieces. This cuts down on the windage while keeping the bandwidth essentially the same.

The reflector is essentially a large grille about 60cm wide and 80cm high. The four dipoles are mounted on a common vertical boom which is spaced away from the vertical boom of the grille by about 50mm.

The antenna is shown in front and side elevation in Fig.1. This diagram labels each special hardware item you will have to make.

These are: (A) the dipole carriers, four required; (B) the dipole mounting clips, eight required; (C) the main mounting plate; (D) balun box assembly; (E) dipole elements, 16 required; (F) the boom tie plates, four required; (G) front boom; (H) rear boom; (J) outer harness connectors, four required and (K) inner harness connectors, four required.

Also shown on Fig.1 but not labelled as such, are the reflector elements, of which 17 are required.

Fasteners

After a few years' exposure to the elements, many antennas are in a poor state. Because aluminium is such an active metal, the right fasteners must be used otherwise corrosion will be very rapid, especially in seaside areas.

We recommend three types of fastener for this project: (1) Aluminium pop rivets with aluminium mandrels. Those with steel mandrels are not recommended. Eventually, their mandrels will rust and while this may not harm the antenna it will cause unsightly discolouration. (2) Though often hard to get, aluminium screws are recommended although they are not available in self-tapping types and so all screw holes would have to be tapped. (3) Stainless steel self-tapping screws. These are strong, readily available and corrosion resistant.

We do not recommend galvanised, bright zinc or cadmium plated steel screws as these do not stand the test of time. Often they will start to rust within a few days' exposure in seaside areas. They may be OK for roofing work but in combination with aluminium they rust. If you live away from the sea and decide to use these types of screw anyway, we recommend that you paint the antenna. We'll talk about that later.

Don't, on any account, use brass or mild steel screws. If you use these, you will spoil the job.

Making your antenna

Most enthusiasts will have the tools needed for this project. You will need a hacksaw, electric drill, vice, pop-rivet gun, blow-torch or LPG cylinder and torch. Apart from a pair of antenna clamps (U-bolts), no special hardware or fittings are needed as we will detail how every part is made.

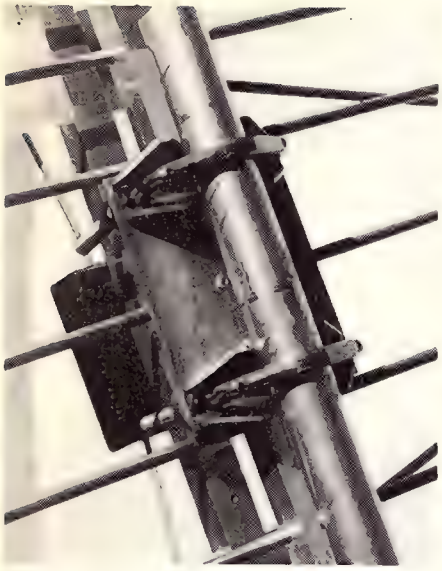
Making and assembling this antenna is a fairly straightforward process although some steps are a little tedious. You must first obtain all the aluminium and hardware listed in the Bill of Materials, and make sure you have access to all the tools we have listed above.

Having assembled together all the raw materials, you can start work by cutting all the aluminium elements with a hacksaw.

Cut the two booms first, which are made of 19mm square aluminium tubing. The details are shown in Fig.2. The rear boom is 812mm, while the front boom is 720mm long. Then centre-punch and drill all the holes in both booms.

Make sure that all the holes for the reflector elements in the rear boom are precisely in line and that their centres are 4.6mm from the front surface as specified on the diagram of Fig.2.

Do not forget the holes for the tie plates or the holes in the back of the rear boom, for the main mounting plate. Trying to drill these after the antenna has been partially pop-riveted together would be a tricky task.



The mounting plate is rivetted to the back of the rear boom and carries two U-bolts to mount the antenna to the mast.

For best results, mount the antenna as high as possible and well clear of other antennas.

Next, cut all 17 reflector elements and the 16 dipole elements. These are made from 6mm aluminium tubing with a 1mm wall thickness. The dipole element dimensions are shown in Fig.3 while the reflector lengths, all 600mm, are shown in Fig.1.

Assemble each reflector element into the rear boom, one at a time. The method we used was to thread one element through the boom, centre it precisely and centre-punch on the front of the boom, at the intersection of the centre-lines of the boom and the reflector element. Drill a 3mm (or 1/8-inch) hole through the front of the boom and element and then pop rivet the two together. Do this for all 17 reflector elements.

Dipole plate & clips

Next, make the four dipole plates, as shown in Fig.4. We used 3mm thick white Perspex but you can use clear Lexan or Perspex as they stand the weather equally well. When drilling, do not use too high a speed otherwise the Perspex will tend to melt and congeal on the drill.

Now, make the eight dipole clips. We cut and bent these from a strip of 1.6mm thick aluminium, 38mm wide. Fig.5 shows the details. Each clip can be cut with tin snips, flattened with a hammer and then each side bent up in a vice.

That done, you can make up the four dipole assemblies, each requiring a Perspex dipole plate, two dipole clips, four dipole elements plus four stainless steel 3mm screws, nuts and lockwashers.

Next, make the four tie plates which tie the front and rear booms together. You can also make the main mounting plate at this stage, since it uses the same material, 1.6mm thick aluminium sheet. The details are shown in Fig.6 and Fig.7.

Now assemble the front and rear booms together, using the four tie plates. You can use pop rivets or stainless steel self-tapping screws for this job.

Fix the main mounting plate to the rear boom, using pop rivets or stainless steel self-tappers.

Mount the four dipole assemblies onto the front boom. Use pop rivets or stainless steel self-tappers.

Your antenna now looks the part and only lacks the harness and balun box assembly.

Make the inner and outer harness connectors, as shown in Fig.8. These are made from 3mm diameter aluminium rod. This is the trickiest stage in the whole process.

After cutting to length, the ends of each connector must be hammered flat. To do this satisfactorily, you will have to anneal each end with a blow torch (or LPG torch). Unfortunately, there is no easy way of judging how much heat to apply but if you overheat the end it will suddenly melt and fall on the floor.

The way to do it is to place each end in the flame for a few seconds and then hammer it flat. If necessary, reheat the end to finish the job. In fact, aim to do the flattening in two steps of hammering and annealing otherwise you will inevitably melt it.

That done, centre-punch each end and drill 3mm holes. The eight connectors are then ready to be attached to the four dipoles but before you can do that you need to prepare the balun box assembly.

Incidentally, note that when the ends of the harness connectors are hammered flat, they spread and stretch quite a bit. This accounts for the fact that the outer connectors are cut to 200mm long but when the ends are hammered flat, the hole centres for the connector screws can be drilled 199mm apart.

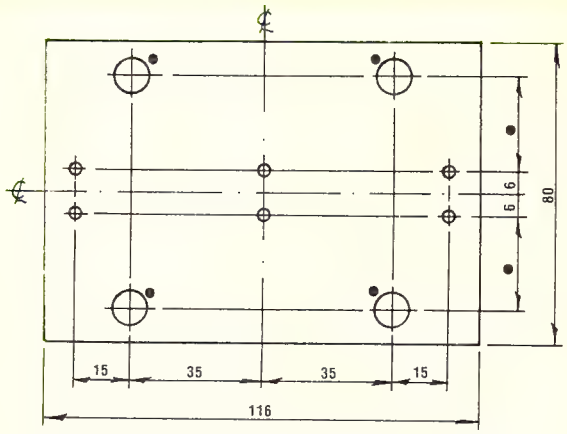
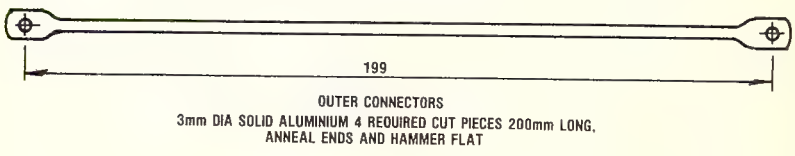


Fig.7: drill the mounting plate to suit the U-bolts and clamps used.



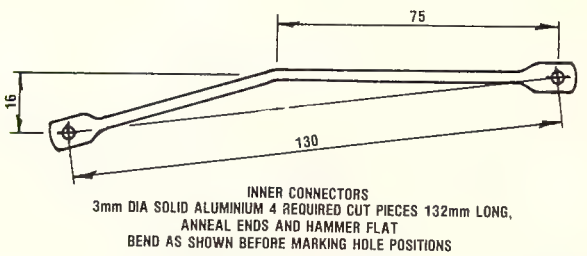


Fig.8: dimensions for the inner and outer harness connectors. Use a blow torch to anneal the ends before hammering them flat.

Balun box assembly

The balun box provides a correct termination for the antenna harness and terminals for 75-ohm coax cable, all sealed away from the elements for protection. It takes the form of a black plastic box with a small printed circuit board inside. This mounts the air-cored balun and the terminations.

The printed circuit measures 30 x 70mm (code SC2-1-0188) and has a very simple pattern. The balun is made of two small coils of enamelled copper wire, as shown in Fig.9 and Fig.10. Use wire with self-fluxing enamel for this job. Self-fluxing enamel melts easily in a solder pot or with a soldering iron and is much easier to work with than high temperature wire enamels which must be thoroughly scraped off before the wire can be tinned with solder.

Incidentally, do not think that the connection of the outer coil of the balun is a mistake, as shown in Fig.10. It is correct, with both ends soldered to earth.

The balun printed circuit board and its accompanying box is tricky to mount. We suggest the following method. First, attach the four harness inner connectors to the printed board using stainless steel screws and nuts. The aluminium conductors must not make physical contact with the copper side of the board.

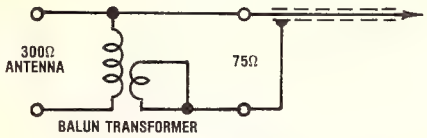
You can use brass or copper plated steel for the coax cable clamp. We suggest you solder brass nuts to the copper side of the board to secure the cable clamp and the screw to terminate the inner conductor of the coax cable.

Fig.11 shows the details of the balun box and how it is mounted. Use one self-tapping screw to secure the box to the front vertical boom. Use two spacers and two self tapping screws to secure the printed board to the case bottom. The latter two screws should penetrate the boom.

Now attach all eight harness connectors to the dipole assemblies and the antenna is virtually finished. Do not over-tighten the dipole assembly screws otherwise the Perspex will distort and possibly crack.

You will need a pair of antenna clamps or U-bolts to mount the antenna to the mast or J-pole (for barge-board mounting). We prefer the use of galvanised U-bolts and V-clamps for this job rather than the cadmium-plated and passivated types used for most antenna hardware. The latter have a gold finish and often start to rust prematurely.

U-bolts and clamps for automotive exhaust systems are



PRIMARY 12T, 0.67mm ENAMELLED COPPER WIRE CLOSE-WOUND ON A 3.2mm DIA. MANDREL

SECONDARY 6T, 0.67mm ENAMELLED COPPER WIRE CLOSE-WOUND ON A 4.76mm DIA. MANDREL

Fig.9: winding and termination details for the air-cored balun.

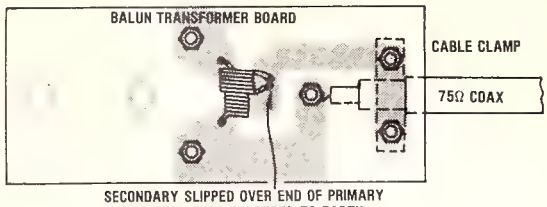
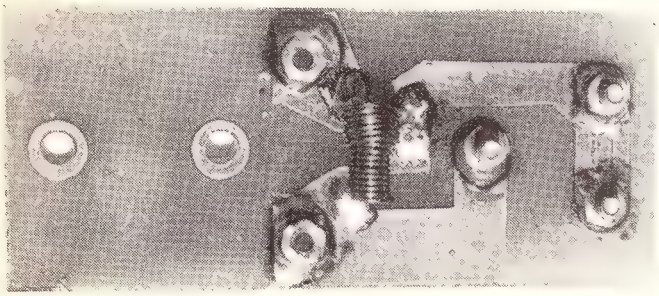
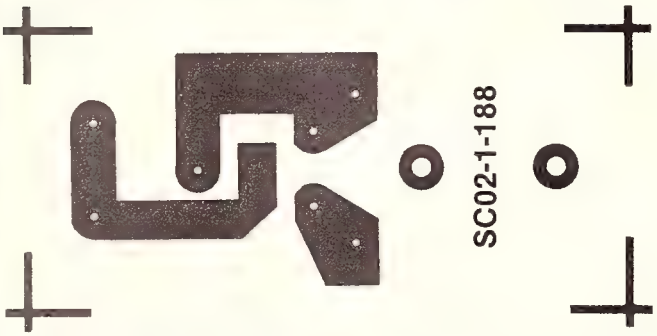

BALUN TRANSFORMER BOARD
CABLE CLAMP
75Ω COAX
SECONDARY SLIPPED OVER END OF PRIMARY
AND BOTH ENDS SOLDERED TO EARTH
BALUN COILS MOUNTED ON COPPER SIDE OF BOARD

Fig.10: the balun coils are mounted on the copper side of the PCB. Note that both ends of the secondary are soldered to earth.



The completed balun board. Brass nuts are soldered to the copper pattern to secure the screws for the cable clamp, coax cable inner conductor, and harness connectors.



This is the actual size pattern for the balun board.

generally quite suitable and have good corrosion resistance. Or, if you want to be really fancy, go to a ship's chandlers and buy stainless steel U-bolts and clamps. They're costly but good.

We suggest that the ends of all the reflector and dipole elements be stopped up with silicone sealant. This will stop them from whistling in the wind. You can do the same with the booms although, for a neater result, you can buy square Delrin plugs.

Installing the antenna

Take a lot of care when installing your antenna. There's no point doing a fine job of assembly and saving all that money if you end up in hospital because you fell off the ladder. Climbing ladders with antennas is dangerous work.

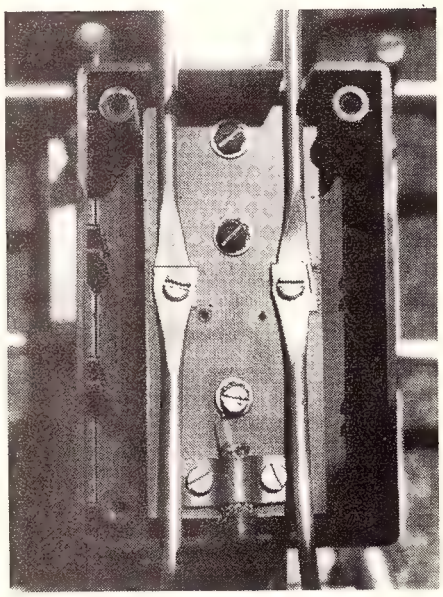
The first step in installation is to decide where to mount your antenna. For best results mount it as high as possible and well clear of other antennas.

It is not really practical to mount this bow-tie array on the same mast as a VHF antenna unless it is vertically separated by at least one metre.

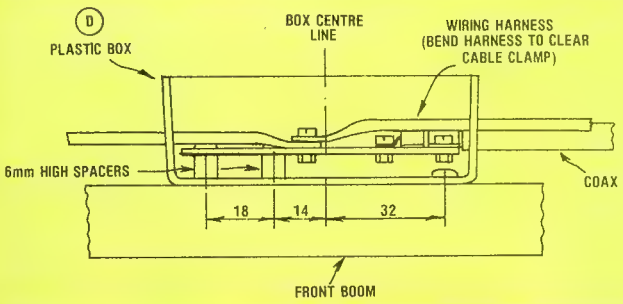
Having mounted your mast, take the antenna up and secure it with the U-bolts. Then terminate the coax cable. For minimum signal attenuation and good cable life, we recommend Hills semi-airspaced cable, type SSC32 or equivalent.

At your TV set end of the cable, you will probably need a diplexer to

continued on page 95



View inside the balun box assembly. It should be sealed against the weather.



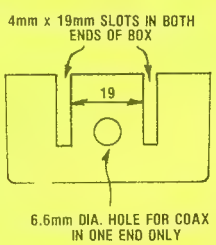
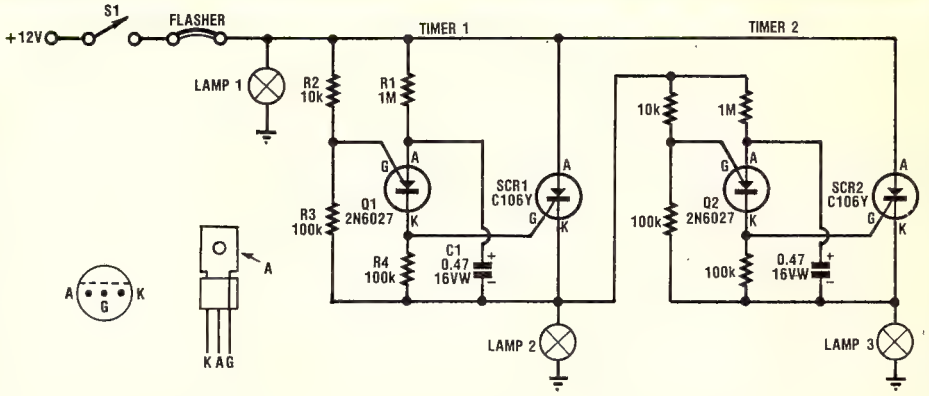


Fig.11: details of the balun box assembly. It is secured to the front boom at one end using a self-tapping screw and at the other end by two self-tapping screws which pass through the PCB and 6mm spacers.

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

Sequential lamp flasher for your car



For those people who are tired of having a single pair of lamps at the rear of their car to indiciate right-hand or left-hand turns, this circuit will make your vehicle different indeed. It allows three lamps to be flashed in sequence. Lamp 1 lights first, then lamp 2 and then lamp 3. Then all the lamps extinguish and the sequence begins again, at the rate set by the car's existing flasher module.

You could add the extra lamps to the rear parcel shelf or mount them externally. Either way would give you much more visible turn signals.

The circuit begins to operate with switch S1 closing. This lights lamp 1 immediately and capacitor C1 begins to charge towards the positive rail. When the anode voltage of Q1 exceeds the gate voltage by 0.5V, Q1 switches on and triggers SCR1. This lights lamp 2 and powers the second timing circuit. This operates in a similar manner to the first timing circuit and lights lamp 3.

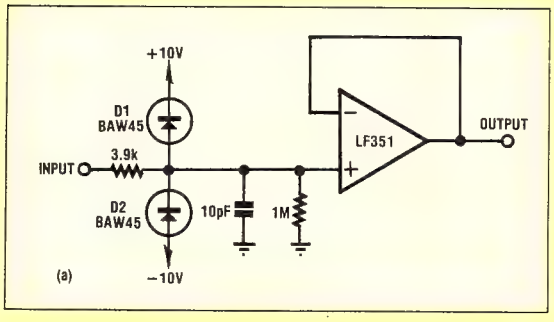
When the flasher module opens, all lamps are extinquished and the sequence recommences when the flasher module closes the circuit again.

Since each SCR drives only one lamp, usually 21 watts or thereabouts, no heatsinking will be required. The time period can be adjusted by changing the value of the 0.47μF capacitors.

Note: this circuit will not work with those flasher modules which place residual voltage across the lamp filaments during the "off" periods. This residual voltage will result in the SCRs failing to turn off and the lamps would cycle once and then flash simultaneously.

High impedance op amp with input protection

The circuit presented here was designed to provide a high impedance input, namely 1MΩ in parallel with 20pF, input protection to at least $\pm$100V and bandwidth limiting to about 2MHz. The first approach is shown in (a). This shows an LF351 op amp in voltage-follower mode (output connected to inverting input) and with input clamping diodes connected to $\pm$10V rails.



The problem with the diodes specified is that they are too leaky. This would not normally be a problem but the gain of the following stage (not shown) is 80. The effect of connecting a low impedance source to the input amplifier was a shift in its output by 250mV. When multiplied by the following stage's gain, this would be enough to overload it.

One solution is to use low leakage diodes such as BAV45s but these cost more than the LF351. Another alternative is to use the gate-source junction of a J-FET. Many of these devices exhibit the right characteristics (not switching types) but have a maximum current of only 10mA. The base-collector junction of many ordinary bipolar transistors, such as 2N3638A, is fine, with leakage currents in the picoamp region.

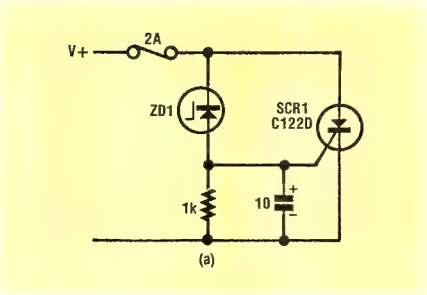
I used PN3653s because they also exhibit quite low junction capacitance. That then raised the concern that the variation of the input voltage might vary the capacitance of the base-collector junction and hence vary the bandwidth with input voltage.

An elegant solution is presented

Crowbar over-voltage protection for power supplies

Most logic circuitry can be damaged if the supply voltage goes too high, even for brief periods. For this reason most power supplies for computer and logic applications have fairly complex circuits to assure good regulation. When this circuitry fails though, the usually well-regulated output goes much higher and following circuitry is usually damaged.

To avoid this, crowbar circuitry is often added, to provide drastic protection in the last resort. In the event of the supply rail going high, a dead short circuit is placed across it. This blows a fuse and renders it safe.

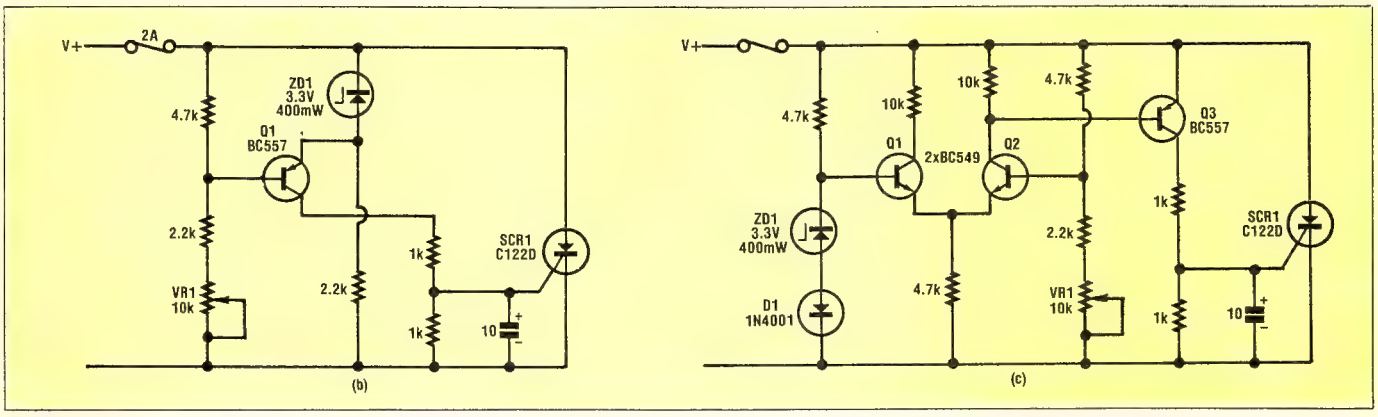


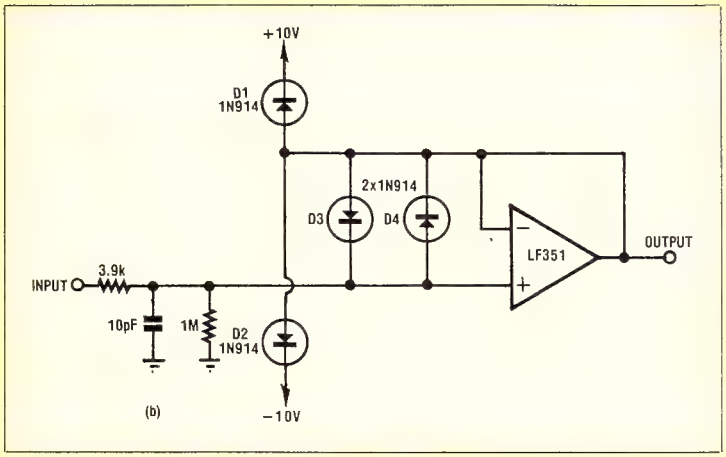
Three crowbar protection circuits are presented. (a) is a simple circuit involving just a zener diode to sense the voltage and an SCR (silicon controlled rectifier) to provide the short circuit and blow the fuse. When the supply voltage rises slightly above the zener voltage, current is fed via the zener into the gate of the SCR to trigger it. The fuse blows within one microsecond which is fast enough to protect semiconductor circuitry.

The problem with this circuit is that it is too dependent on the particular zener characteristic and on the trigger current of the SCR.

(b) is a better circuit. Q1 acts as a comparator, comparing a preset voltage at its base with the zener voltage at its emitter. Because of the gain of Q1, the circuit has a much more precise trigger point and it has the advantage of being adjustable with VR1.

(c) is better still. The diode in series with the zener provides temperature compensation of the reference voltage. The circuit has higher gain and the differential amplifier acts as a more precise comparator.





in (b). This shows the 1N914s strung across the input of the op amp and with further clamp diodes connected to the output. The ± 10V rails must then be able to handle the full current of the op amp when it is over-driven.

This configuration eliminates the leakage problems of the 1N914s because they have virtually no voltage across them until the input is overloaded. At other times the input diodes are effectively bootstrapped out of circuit by the op amp's output.

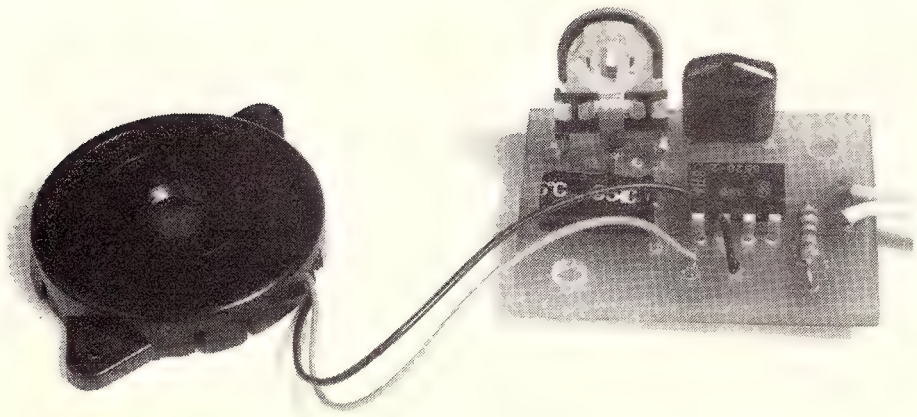
$20 to: Phil Denniss,
University of Sydney.

Substituting electros

Where an electrolytic capacitor is specified in a circuit, you can always substitute a capacitor with a higher voltage rating, provided that the size of the capacitor is not a problem. You can often also substitute a capacitor with a lower voltage rating, provided the voltage across the capacitor is not likely to be exceeded.

Circuit designers often standardise on capacitors with only two voltage ratings, say 16V or 25V. In many cases though, a capacitor rated for 25V may have much lower voltage impressed across it which gives the opportunity for substitution.

Update the sound



Are you tired of the sound of your telephone bells? You can change to a modern sounding chime by building this simple module.

Apart from wishing for a change in the sound of your old telephone bells, there is another good reason for building this personal phone ringer. If you work in a large office with many telephone extensions, it can be very difficult to tell whether it is your phone that is ringing or not.

With this little circuit wired in place of the existing bell or solid state chime, you can set the tone of your phone so that it is distinctly different from all the other phones. That way, if you are away from your desk, you won't be wondering if it is a call for you every time a phone starts to ring.

Another reason for using this ringer circuit instead of your phone's existing bells may be if you or someone in your household is partially deaf. You may not want to go to the trouble and expense of having an extension bell installed if this ringer can do the job.

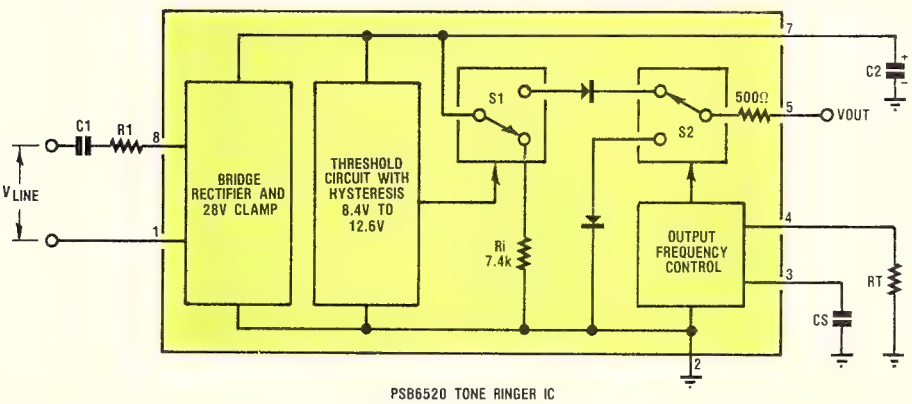


Fig.1: block diagram of the PSB6520. Rt sets the oscillator frequency while Cs sets the rate at which the oscillator is modulated.

Our phone ringer has been designed to go on a small printed circuit board which can be installed in just about any phone although we expect that most will be installed in older phones with electromechanical bells.

Only six components are used in the circuit, five of them mounted on the printed circuit board (PCB). The exception is the piezoelectric transducer which actually produces the chime sound.

How it works

The heart of the phone ringer is a Siemens PSB6520 tone ringer integrated circuit (IC) which is specifically designed for use as an electronic bell in a telephone set.

The functions of the PSB6520 IC are shown in Fig.1. When a ring signal tone is sent down the telephone line, the voltage is coupled via capacitor C1 while the current is limited with series resistor R1. An internal bridge rectifier converts the AC ring tone to a DC voltage which is clamped to a maximum of 28V. C2 at pin 7 is a filter capacitor to provide a smoothed DC voltage.

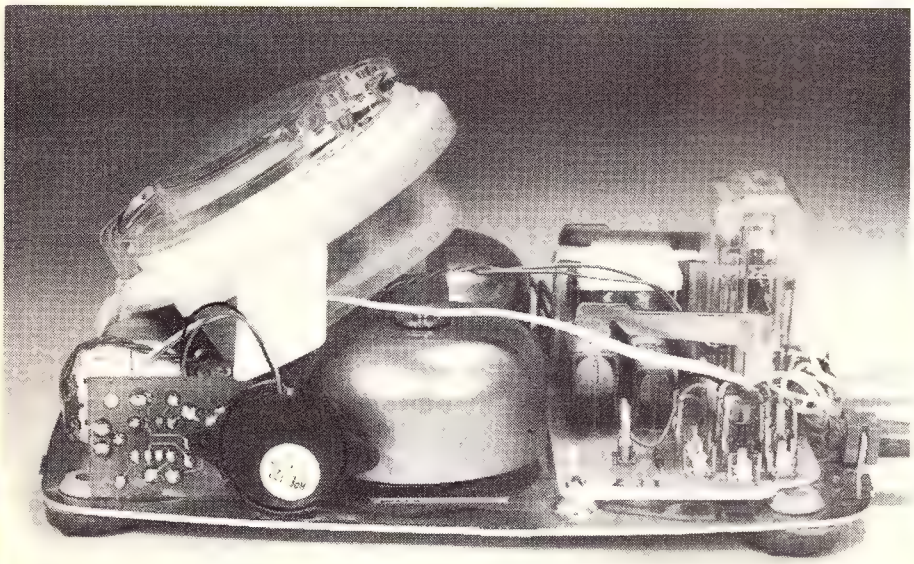
When the DC voltage derived from the ring signal reaches about 18V the oscillator circuit begins to operate with switch S1 closing to the upper position. If the DC voltage falls below 8.4V, S1 will reclose to the lower position and the oscillator will cease operation.

Resistor Rt at pin 4 sets the frequency of the oscillator while capacitor Cs sets the rate at which the ocillator is modulated to produce its pleasant burble tone. Naturally, the tone is audible only while the ring voltage is present, so instead of going *ring ring* your phone will now go *chirple chirple*.

Fig.2 shows the final circuit. As can be seen, we have not included capacitor C1 in the circuit, since all telephones will already have a

# of your phone

Design by
JOHN CLARKE



We installed the prototype in this phone by glueing it to one of the flat metal pillars which support the dial mechanism (bottom left).

PARTS LIST

- 1 PCB, code SC121-1287, 28 x 36mm
- 1 PSB6520 tone ringer IC (Siemens)
- 1 piezo transducer (Jaycar Cat. AB-3440 or equivalent)
- 1 10μF 63VW PC electrolytic capacitor
- 1 0.1μF metallised polyester capacitor
- 1 22kΩ miniature vertical trimpot
- 1 2.2kΩ 0.25W resistor

Miscellaneous
Solder, hook-up wire.

capacitor for the existing bell or ringer circuit. The value for Cs is 0.1μF while a 22kΩ trimpot is used for Rt. The 10μF capacitor at pin 7 of IC1 filters the DC supply.

Assembly

Assembling the printed board is not an onerous task since there are not many components. The only point to watch is the need to install the IC and the 10μF capacitor the right way around.

When you have installed and soldered all components into circuit you can check the unit on a DC power supply. Feed in about 20 volts DC to the input terminals and note that you get a continuous "chirple" sound from the piezo transducer. You can adjust the frequency of the oscillator with the trimpot to suit your taste.

For optimum results though, we suggest you slowly vary the trimpot until the sound from the transducer is loudest. There will be distinct setting for the trimpot which gives a much louder sound output than any other. This corresponds to the

continued on page 85

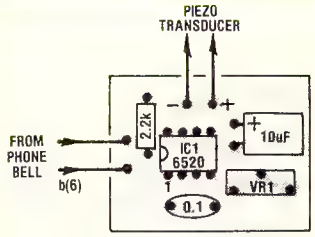


Fig.3: parts layout for the printed circuit board.

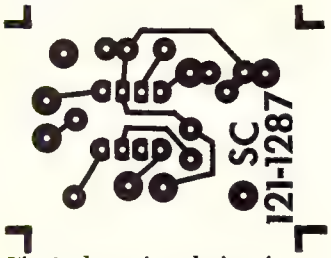
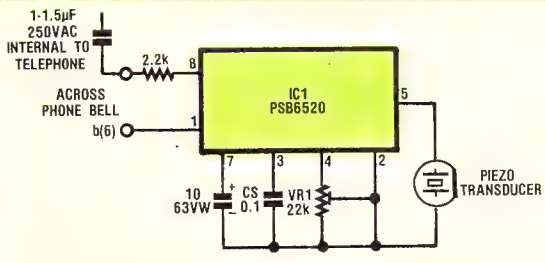


Fig.4: the printed circuit board measures 28 x 36mm.



PERSONAL PHONE RINGER
121-1287

Fig.2: the complete circuit diagram for our phone ringer.

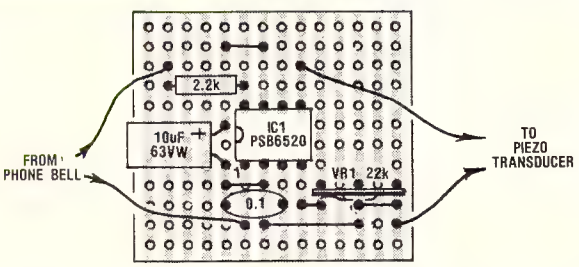


Fig.5: the circuit is so simple, it can easily be assembled on a small piece of Veroboard. Use an oversize drill bit to make the cuts in the tracks.

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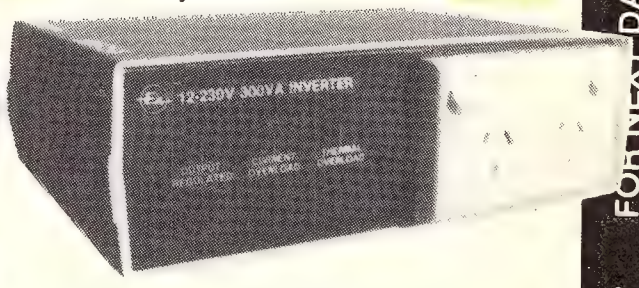
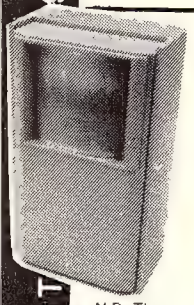
Fully Built & Tested





New Model IRD Has Fantastic Range

With Two Mode Lens

Why Pay $150 or More

Our Price **$99ea**

10 or More **$90ea**

Features:

- Lens simply 'snaps' to either **wide angle** (range 40 feet) for normal use or **Normal angle** (range 80 feet plus) for corridor applications.
- Snazzy integral mounting bracket allows corner 90 deg. mounting as well as normal surface mount.(This is a fantastic feature as these work best in corners and are visually unobtrusive)
- 12V DC Powered
- Built-in test lamp
- Alarm output SPDT 30V 1a

S 5301

N.B. These professional detectors use state of the art circuitry to achieve ultra reliability in operation. They are currently specified by several "Name" commercial Security Companies

MICRO EYE VECTOR

We believe the Vector to be one of the finest and most sensitive Radar Detectors available in the World today. Approximately 4db greater sensitivity than the A 1520

Until now, GaAs diodes have only been used in sophisticated military radar equipment. The Microeye Vector is the first consumer electronics product equipped with this new technology.

Why GaAs Diodes Make The Difference: • Lower threshold allows for a better signal to noise ratio. • Lower signal conversion loss. • Higher barrier reduces noise. Quite Simply, GaAs diodes increase the sensitivity of the Microeye Vector.

Features: • Separate audio alerts for X and K Band. • Three operational switches: **Power:** On and Off: RSD (Radar Signal Discriminator) to minimize extraneous signals with a LO (local) positon and a LR (Long Range) position; **Filter** Mode designed for instant computerized analysis of incoming signals with LO and LR positions.

Invisible from outside your car. The Vector simply clips onto your sun visor. Thus the Gendames and would be villains are non the wiser.

A 1530

Counter Kit
(See Silicon Chip Mag. Nov 1987 for Details)

Our Congratulations to Leo and Greg at Silicon Chip for this Great Australian Design

The Technical excellence of this counter places it with Hewlett Packard and other world famous test equipment makers.

K 2515 Due Mid Dec'

UV Eprom Eraser

Erase your EPROMS quickly and safely. This unit is a cost effective solution to your problems. It will erase up to 9 x 24 pin devices in complete safety in about 40 minutes for 9 chips (less for less chips).

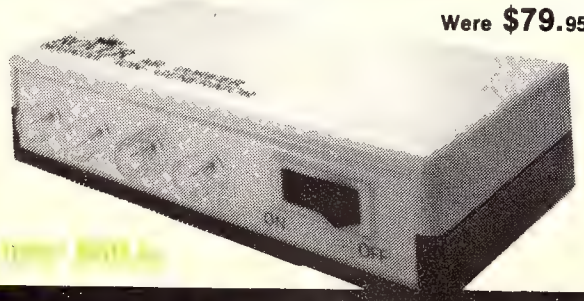
•Erase up to 9 chips at a time • Chip drawer has conductive foam pad • Mains Powered • High UV intensity at chip surface ensures thorough erase • Engineered to prevent UV exposure • Long Life UV tube • Dimensions 217x80x68mm • Weight 670g.

$99

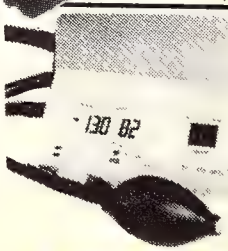
Super Bargain 1/2 Price

There have been volumes written about the benefits of negative ions combating air pollution, cigarette smoke etc. can be very beneficial to Asthma sufferers. Our great little Rover generates billions of ions per second! Includes tester.

Were $79.95



Heart disease strikes down many people in their early 40's (or even 30's). The tragedy remains that had such victims been alerted, remedial medical, physical and dietary action could have been prescribed to avoid illness and in many cases restore full bodily health. **X 3055**



Blood Pressure and Heart Rate Monitor

Features:

- Non-Microphone Measurement System
- LCD Readout
- Blood Pressure Monitor
- Pulse Rate Monitor

X 3055 **Only $110**

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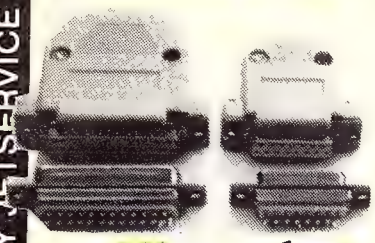
Save Up To 50% On Top Quality D Series Connectors!
Fantastic Value

D Series Computer Connectors. Gold Plated Professional Series

Items Marked • are 1/2 Price or Less



DB9

		WERE
P 3000	Male 9 Pin	2.95
P 3010	Female 9 Pin	3.25
P 3020	Male PCB Rt/L	3.75
P 3030	Fmale PCB Rt/L	4.50
P 3040	Male PCB mnt.	2.95
P 3050	Fmale PCB mnt.	3.95
P 3090	Backshell cover	1.95

DB15

P 3100	Male 15 Pin	3.25
P 3110	Fmale 15 Pin	3.85
P 3120	Male PCB Rt/L	4.35
P 3130	Fmale PCB Rt/L	5.50
P 3140	Male PCB mnt.	3.85
P 3150	Fmale PCB	4.85
P 3190	Backshell cover	2.20

DB25

P 3200	Male 25 Pin	4.95
P 3210	Fmale 25 Pin	5.50
P 3220	Male PCB Rt/L	4.95
P 3230	Fmale PCB Rt/L	6.90
P 3240	Male PCB mnt.	4.95
P 3250	Fmale PCB mnt.	6.25
P 3290	Backshell cover	2.20

High Quality — High Power Ratings

Polypropylene Loudspeakers

Virtually all the famous "Name" loudspeaker makers now use Bextrene or Polypropylene Cones with their drivers. The advantages are considerable - less cone flexing or "break up", improved bottom end response and reduced enclosure sizes.

One of the problems of course, has been the high cost of P-P drivers. Fortunately, **with Altronics direct import prices, you can now be the owner of any of these fine speakers for a fraction of what you'd expect.**

Note: the conservative power ratings, the massive magnets employed and high order sensitivity specifications with these fine Drivers.

Brief Specifications (All 8 ohm Voice Coil Impedance)

5 1/2" Woofer/Midrange

C 3055 $24.50

Frequency Response fo—3000Hz **Resonant Frequency** 36Hz **Sensitivity** (1M/1Watt) 87db (+ or -2db **Voice Coil** 25mm **Nett Weight** 900gm **Electromagnetic Q** .48 **Magnet** 280 gm.

6" Woofer

C 3060

Frequency Response Fo—3000Hz **Resonant Frequency** 33Hz **Sensitivity**(M/1Watt) 90db (+ or -2db) **Voice Coil** 38mm **Nett Weight** 2200 gm. **Electromagnetic Q** .4 **Magnet** 836 gm.

10" Woofer

C 3065

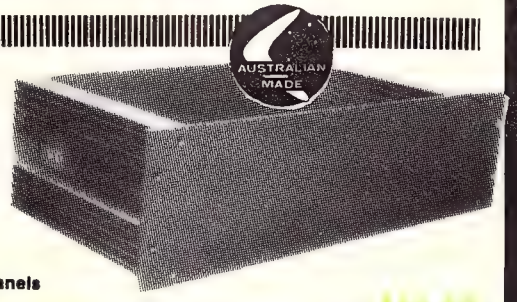
Frequency Response fo—3000Hz **Resonant Frequency** 30Hz **Sensitivity (1M/1Watt) 92db** (+ or -2db) **Voice Coil** 38mm **Nett Weight** 2650 gm **Electromagnetic Q** .23 **Magnet** 836 gm.

12" Woofer

C 3070

Frequency Response fo—2000Hz **Resonant Frequency** 23Hz **Sensitivity** (1M/1Watt) 93db (+ or -2db) **Voice Coil** 38mm **Nett Weight** 3620 gm **Electromagnet Q** .22 **Magnet** 1410 gm.

High Energy Rack Case



The use of Super Heavy Duty Heatsinks as Rack Case sides now allows a myriad of Amplifiers, Power Supplies, Battery Chargers etc. to be built in an "Off the Shelf" rack case.

Fantastic for Stereo Amplifiers—Each Heatsink will accommodate an audio output stage of approximately 120W with normal efficiency and dissipation.

A Great Chassis for Heavy Duty Power Supplies and Battery Chargers. We suggest the mounting of Rectifier Bridge or diodes on one Heatsink and the Regulator devices on the other.

Order With Either Black Or Natural Anodised Front Panels

H 0417 Natural Anodised Front Panel $99.00 H 0418 Black Anodised Front Panel

Specifications:

Heatsinks Altronics H 0590 **Front Panel** 3 unit Rack size 480mm x 132mm x 3mm **Base** 1.0mm steel, ventilation slots provided **Top Cover** 1.0mm steel, ventilation slots provided **Internal Dimensions** 125 x 370 x 250mm **External Dimensions** 130 x 440 x 252mm plus standard front panel **Finish** Black anodised aluminium plus powder coat black top/base.

PROFESSIONAL SERIES RACK CABINETS

Now your preamps, Amps, Control Modules Monitor Panels etc. can look every bit as good as Technics Nakamichi and other top manufacturers.

ALL ALUMINIUM CONSTRUCTION

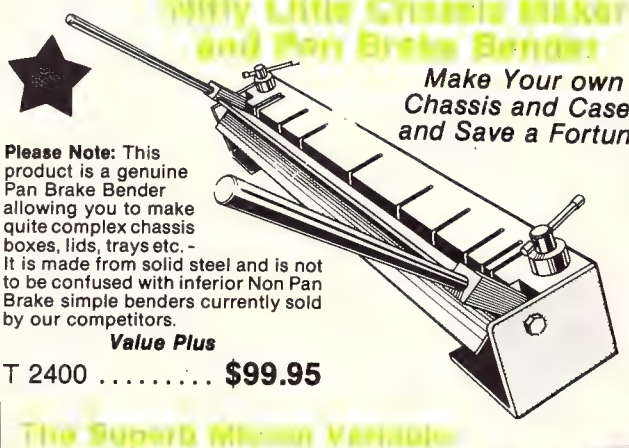
FEATURES: These beautifully crafted rack cabinet boxes will give your equipment a real 1st class appearance with removable top and bottom cover panels • All dimensioning conforms to the International Standard • Natural or Black finish • Ventilated lid • Deluxe finish front panel • Individually cartoned • Supplied in Flat Pack Form - Easily assembled in minutes - **Side Elevations:**- D=254mm C (Internal Chassis Height) • B (mounting Bolt Centres).

SIX NATURAL AND BLACK FINISH MODELS — The Black or Natural finish cabinets are each available in 44mm, 88mm or 132mm high models. Mounting hole centres conform exactly to International Racking Specifications both vertically and horizontally.

Cat. No.	Finish	A	B	C	Were
H 0401	Natural	44	34	38	$59.95
H 0402	Natural	88	57	82	$69.95
H 0403	Natural	132	89	126	$85.00
H 0411	Black	44	34	38	$59.95
H 0412	Black	88	57	82	$79.95
H 0413	Black	132	89	126	$89.95

Nifty Little Chassis Maker and Pan Brake Bender

Make Your own Chassis and Cases and Save a Fortune

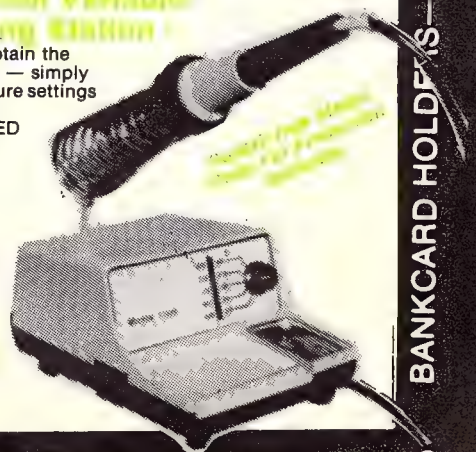


Please Note: This product is a genuine Pan Brake Bender allowing you to make quite complex chassis boxes, lids, trays etc. - It is made from solid steel and is not to be confused with inferior Non Pan Brake simple benders currently sold by our competitors.

Value Plus

T 2400 ..... **$99.95**

The Superb Micron Variable Temp Soldering Station



No more changing tips to obtain the correct working temperature — simply select any one of 5 temperature settings between 320 and 440 deg. C

Temperature Readout via. LED bargraph.

Temperature Stability to within 4% of selected mean temperature.

Heat Capacity full 48 watts available for H/D work.

★ Low Voltage Element ★ Silicon rubber burn resistant lead ★ Chrome plated iron clad tips.

T 2440 $125

Be Quick! Next Month $139

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Own An Inphone And Your Neighbours Will Be Green With Envy

Here's Why

★ No Installation Costs

Simply Plugs Into Your Phone Socket

★ Inphone Is Great Around The Factory or Building Site

Its Completely Mobile The Go Anywhere Cordless Inphone is not tied to the wall with wires — you simply take it where you want. Never again need you spend half the night crouched around the kitchen bench or draughty hallway with those long winded calls.

★ Use It By The Fireside In Your Favourite Chair

★ Super Handy When Sunbaking By The Pool

Special Price To Silicon Chip Readers This Month

You Can Use The Inphone Handset Up To 250 Metres From The Base Unit

Why Pay $329?

INPHONE is quite simply the finest cordless phone available. No other cordless phone has the quality, security and the features at any where near an affordable price of INPHONE.

AT HOME you can keep in touch around the swimming pool. (Please note the equipment is not waterproof). In the garden. Under the car. While watching T.V. In the bathroom. In Bed. Or next door when you're playing cards or having a Barbecue with your neighbours.

IN BUSINESS a busy executive can take the INPHONE around the factory, warehouse, showroom, sales yard or construction site or into the car park, and not miss a deal! Also INPHONE is ideal for use in restaurants.

IN SPORT on the field or track, the gym, around the swimming pool, Lifesavers on the beach etc.

Comprehensive 6 months Warranty

Brilliant Performer

inphone ALTRONICS

SIMPLY GREAT AROUND THE POOL

Normally Great Value At $269

Exclusive Offer To Readers Of Silicon Chip Magazine This Month $199 — But You Must Mention This Advert When Ordering

We Regret This Special Offer May Not Be Available From Altronics Dealers

$199

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Just Imagine a Security/Alarm System you can Install in about an Hour — Uses No Wiring or Cables and Costs Less than $1 for the Mounting Hardware

Fantastic UHF 305MHz Microprocessor Control Wireless Security Alarm System

Commercial grade, quality alarm systems are expensive — Just phone one of the "Name" security firms and get a quote for your home—our estimate is that it will be anything up to $1,000 just for the equipment-**then there is the installation**-countless holes punched through walls, miles of wiring and a day or two of installers labour and **that's around $25 per hour these days. Hardly worth the effort is it? After all what have you got to loose?—Only the Video Player, CD Player, Camera, HI FI, TV, Jewellery and so on!!**

Well all that is now changed—with our brilliantly engineered Home Guard Wirless Security System Read On—

Take it With You If You Move

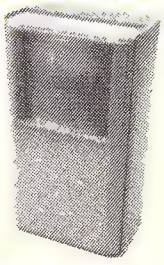
Apart from the flawless operation of the Home Guard System—One of the great features is its application with rented or leased premises—Lets face it, money spent on installing a wired system in your Home or Office, Factory etc. is irrevocably lost when you move on. With the Home Guard you simply take it with you.

This alarm system is a brand new design that features completely wireless connection to all accessories, even the reed switches. Think of how easy it is to install a "Wireless" alarm system. The benefits are endless, e.g. arming your Flat or Townhouse with an alarm you don't need to run wires through the roof or drill great holes through your walls. When moving house the alarm is simple to dismantle and re-install elsewhere.

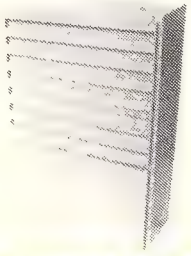
The system divides protected areas into either perimeter zone or internal zone, programmable by dip switches in each transmitter/detector. **Pocket remote control** can simply arm or disarm your house perimeter from your bedside when retiring etc. this allows essential protection while cancelling internal zone as desired. Each transmitter/detector unit can be programmed into interior or perimeter zone. Zones can be programmed for instant or delayed trip. The system has a built-in ear piercing siren for intrusion and panic alarm signals. It also has another dry relay output with normally closed, normally open contacts for connecting to other alarm reporting devices such as telephone dialer, additional outdoor siren etc.

Passive Infra Red Movement Detector

Ideal for the lounge room, family room or hallways e.g. anywhere where an intruder is likely to pass through. Mounts up on the wall or on top of bookshelves etc. Detects movement within an area of 9M by 9M by sensing intruder body heat movement through the protected area Should not false trigger with the family cat or curtain movement etc. — as is the case with the cheaper Ultrasonic alarms.



S 5280 ..... $129



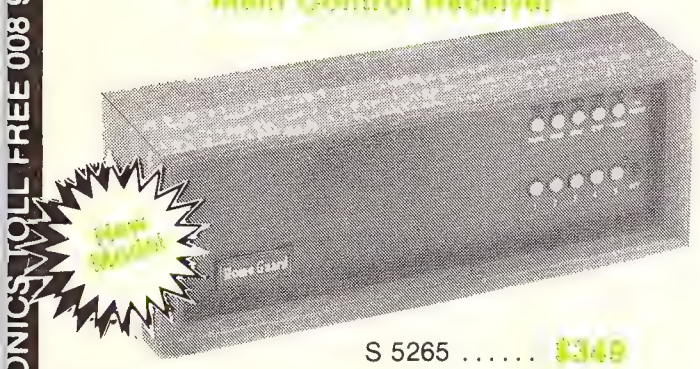
Remote Piezo Siren

This unit is an optional line carrier receiver. Receives signal through 'AC' line i.e. it would ideally be located in, say, the roof space and plugged into mains power.

S 5290 ..... $125

System Is Comprised Of :

Main Control Receiver



S 5265 ..... $349

Features:

- Wireless reception of external or internal sensors or detectors.
- Selectable home or away modes for selecting internal and external arming or just external to allow movement inside the building
- Built in Piezo electric siren gives different signals to indicate different functions.
- Sends signal down power line to activate one or more remote sirens.
- Programmable Arm/Disarm switch buttons.

The main control receiver runs on 240V AC with a 12V 1.2AH battery for emergency backup. All other units with the exception of the line carrier, run on a 9V battery each. The average life expectancy is approximately one year. System works around the 305MHz frequency where there is less chance of false alarm. The range of the unit is normally 80 metres in open space.

Alarm and Indication Sounds

Intrusion Alarm — Panic Alarm — Arm Tone — Disarm Tone — Exit Click Tone — Monitor Tone — Tampering Alarm.

Detector/Transmitter Unit (Reed Switch)

Suitable for Windows and Doors

This consists of an enclosed reed switch and compact UHF transmitter and a removable enclosed magnet. The unit is at rest when magnet and reed are side by side (within 25mm or 1 inch). When the magnet is moved away more than approximately 1 inch the alarm signals to the Main Control Receiver and the alarm is sounded. In practise the Reed/Transmitter is mounted on the door or window frame with the magnet on the moving door or window.

S 5270 ..... $65

Complete System Special Package Price

Comprising:

One S 5265 Main Controller
One S 5270 Reed Switch
One S 5280 Passive I/R Detector
One S 5285 Wall control unit.
Including Batteries

System Cat.No. S 5260..... **Value $579**

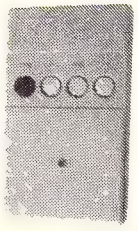
Accessories

Note: For larger installations your system may well require several Reed switches, movement detectors and 2 or more sirens. Also the remote door controller and or pocket remote controls could be very worth while accessories. The fantastic thing about the Altronic system is you simply add more detectors as you discover the need — no wiring, no expensive technicians, no modifications to equipment.

Hand Held Control Transmitter Unit

A real joy to use — keep it at the bedside table — allows you to, say, alarm the house perimeters when retiring or you can take it with you when you go out, arming your system after you lock the door. Unit is a function control transmitter — to send 4 different signals.

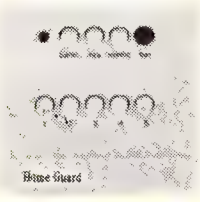
Off — To disarm the system before entering. **Home** — To instantly arm the system with 'Perimeter' detection only. **Away** — To arm complete system after a given exit delay time of about 40 seconds. **Panic** — To start an emergency signal whenever needed, in any mode.



S 5275 ..... $59

Front Door Keypad Control Unit

This handy accessory virtually duplicates the function of the Master Controller unit but at a more convenient location i.e. just inside your entry door etc. System can thus be armed or disarmed without the need to go to Master unit. Especially handy for larger homes or offices.



S 5285 ..... $89

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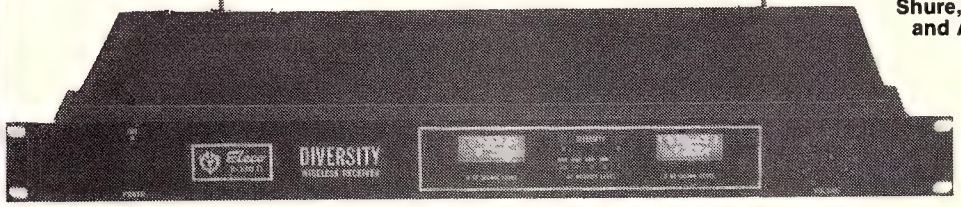
Superb Eleco Wireless Microphone System uses Dual Diversity Receivers for Long Range, Noise Free Pure Fidelity Reproduction.

Now Available In Australia For Less Than $1,000

Altronics proudly release the Eleco System - Used Worldwide by Entertainers i.e. Rolling Stones, Dire Straites, Tina Turner and 1000's more!



Superb Microphone Reproduction Compares with Shure, Beyer and AKG

Unique Microphone design completely Eliminates "Dangling" Antenna

Breathtaking performance without signal drop-out or noise interference. The Eleco Wireless Microphone System is virtually the ultimate in an Entertainers Microphone system (or for any roving microphone application for that matter!)

All the annoying wireless microphone characteristics such as "drop out", static and noise are completely eliminated by use of **auto switching dual diversity receivers.** The output of each receiver is continually monitored, with the strongest and clearest signal always selected. **Dynamic Range exceeding 100 db** is obtained by employment of a Patented special Parabola level compressor and Dynamic expander.

The operating range is a minimum of 50 metres (often this can be extended to 200 metres and more in normal circumstances).

Several Frequencies are available to aleviate cross interference when two or more systems are used in proximity.

Brief Specifications Frequency 202.1, 202.9, 203.7 MHz (Please specify if you have a preference)
Mic Carrier Power 50mW (Max) **Mic Antenna** built-in **Dynamic Range** over 100db **S/N Ratio** better than 90db **Frequency Response** 20Hz to 16KHz + or - 3db **Mic Battery** 4 x AA cells **Battery Life** over 24 hours continuous operation. **Receiver Sensitivity** 12db/micro volt for 60db S/N ratio **Pre emphasis/De emphasis** 50us. **Receiver output** unbalanced 6.3mm phone jack and balanced 3 pin cannon type. **Output Level** (adjustable) Unbalanced 0-2.5V Balanced O to + or - .3V into 600 ohms. **Receiver Power Supply** 200 - 260VAC.

Prices

(A) Dual Diversity Receiver **$729.00**
(B) Entertainment Microphone (hand held type) **$349.00**
(C) Lavalier Type Microphone **$349.00**

Bonus Offer SAVE $78 Choose Receiver and Either Microphone For Just $999

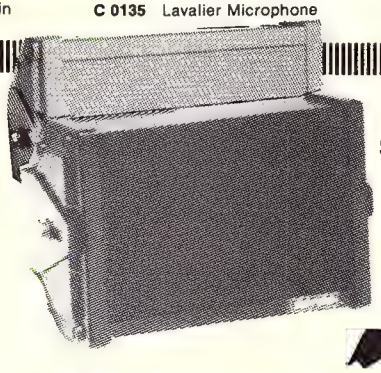
Please Note 3 different operating frequencies are available (you will need to specifically nominate desired frequency only if the equipment is being used in proximity with other Eleco Systems on the 200MHz band.

Frequencies

C 0111	Dual Diversity Receiver	202.1MHz	**$729**
C 0113	Dual Diversity Receiver	202.9MHz	**$729**
C 0115	Dual Diversity Receiver	203.7MHz	**$729**
C 0121	Entertainment Microphone	202.1MHz	**$349**
C 0123	Entertainment Microphone	202.9MHz	**$349**
C 0125	Entertainment Microphone	203.7MHz	**$349**
C 0131	Lavalier Microphone	202.1MHz	**$349**
C 0133	Lavalier Microphone	202.9MHz	**$349**
C 0135	Lavalier Microphone	203.7MHz	**$349**

AT LAST Design Quality Weather Proof Speakers And Sound Columns By *Redford*

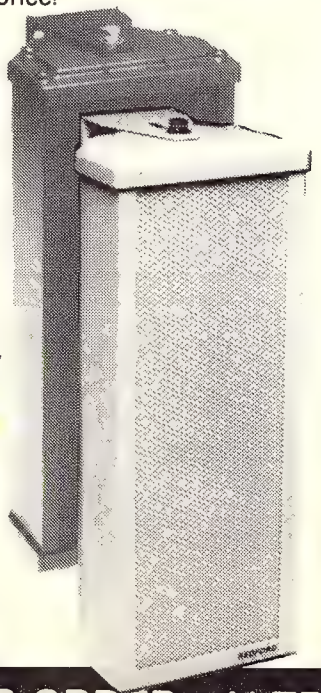
• Rugged extruded aluminium construction • Superb powdercoat industrial paint finish • Engineered in Australia • Excellent reproduction • Superior to imports — Yet just a fraction of the price!



Wide Range Weatherproof Extension Speakers For Your Stereo System

Great For The Back Patio, Swimming Pool, Games Room, Den, Pool Room Etc.

Dimensions 260mm wide x 170mm high x 150mm D. (Mounting brackets are included)



Altronics proudly announce the release of the superb ***Redford*** Weatherproof Speaker and Sound Column Range. Imagine a wide range speaker system which is highly directional and with efficiency approaching that of reflex horns!

Redford is the solution for high quality sound reproduction outdoors. The Five Models to choose from "Fill the Bill" from applications on boats to high grade paging and music entertainment installations.

RUGGED EXTRUDED CONSTRUCTION

These vibration free enclosures are constructed from die extruded heavy gauge aluminium and finished with incredibly durable industrial powdercoat enamel. The speaker ends are sealed via gaskets and tough moulded "LURAN S" U / resistant end caps. The end result is "Good Looks" together with assured rugged durability for the Australian environment.

EXCELLENT REPRODUCTION

The drivers have been chosen for wide range, low distortion, mid range "presence" (essential for high grade vocal work) and high efficiency in general. **Power Capacity** for short term use, the drivers will safely handle 150% of rated power. Acoustic wadding is used to dampen Bass resonance. **Weather Proof Construction and use of "Doped Cones"** Foam plastic and cloth is sandwiched between Baffle and Front Grill to prevent water ingress. A first for ***Redford*** is the use of a patented cone moisture repellant process for all models.

15 Watt 4 and 16 Ohm Models

Using a dual doped cone driver these fantastic weatherproof speakers are of quite surprising performance.

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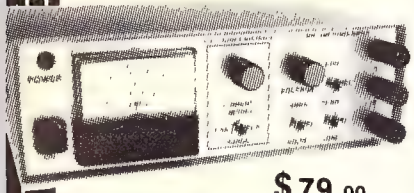

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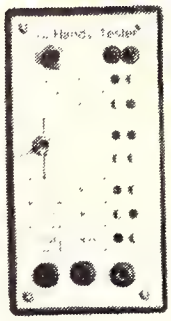

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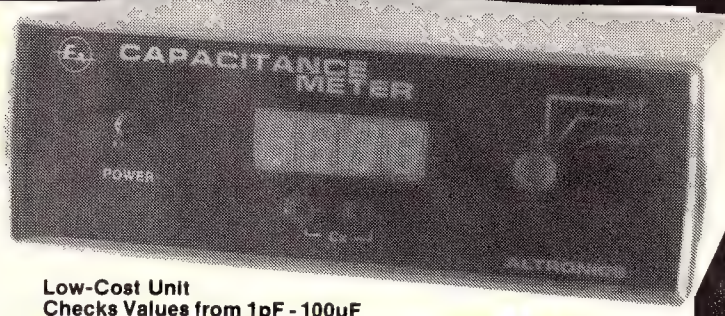

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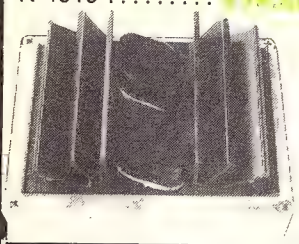

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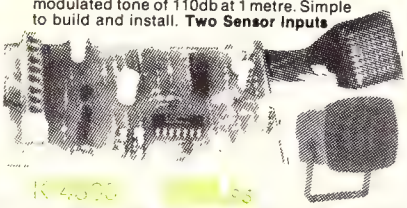

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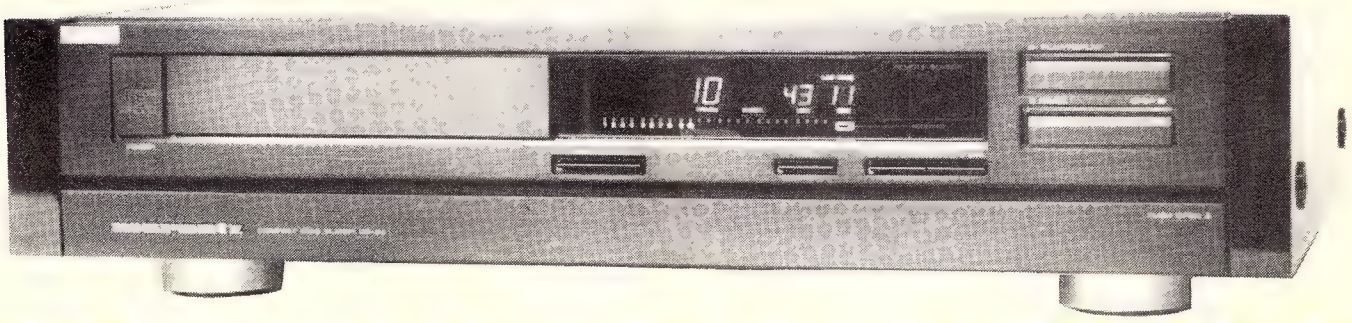


Marantz's elegant CD-94 compact disc player

Marantz is moving up market. That's the very strong conclusion we came to after looking at their latest CD player, the CD-94. This machine leaves previous models for dead in terms of operating refinement, sound quality and, most of all, finish.

Reviewed by LEO SIMPSON

In the last few years Marantz has gone through its vicissitudes but now it has a new direction and commitment to the highest audio fidelity. This new direction has been mostly due to its chief audio designer Ken Ishiwata, a Japanese-born engineer operating at Marantz headquarters in Eindhoven, Holland.

His hand was clearly demonstrated in Marantz's award winning PM94 stereo amplifier and one can see that a great effort has been made to achieve the same standards with the CD-94.

Let's face it. There are many cheap compact disc players on the market and as far as most people are concerned these do a perfectly satisfactory job; they play the music and they do it to a far higher standard than their delighted owners were probably used to with their disc-based equipment.

But there is more to the compact disc than just the basic CD players. There are a substantial number of people who want quite a lot more than the basic machines offer. And up till now, there have not been many machines catering to their needs. There probably never will be but this new machine from Marantz is certainly a contender for the very top of the market.

Unfortunately, mere photos do not do the Marantz CD-94 justice. They can't show the very fine finish. They can't show the glass-like texture of the timber end panels, the subtle colouring of control panel illumination and major control lights. Nor do they show the solidity of the machine, or the action of its controls.

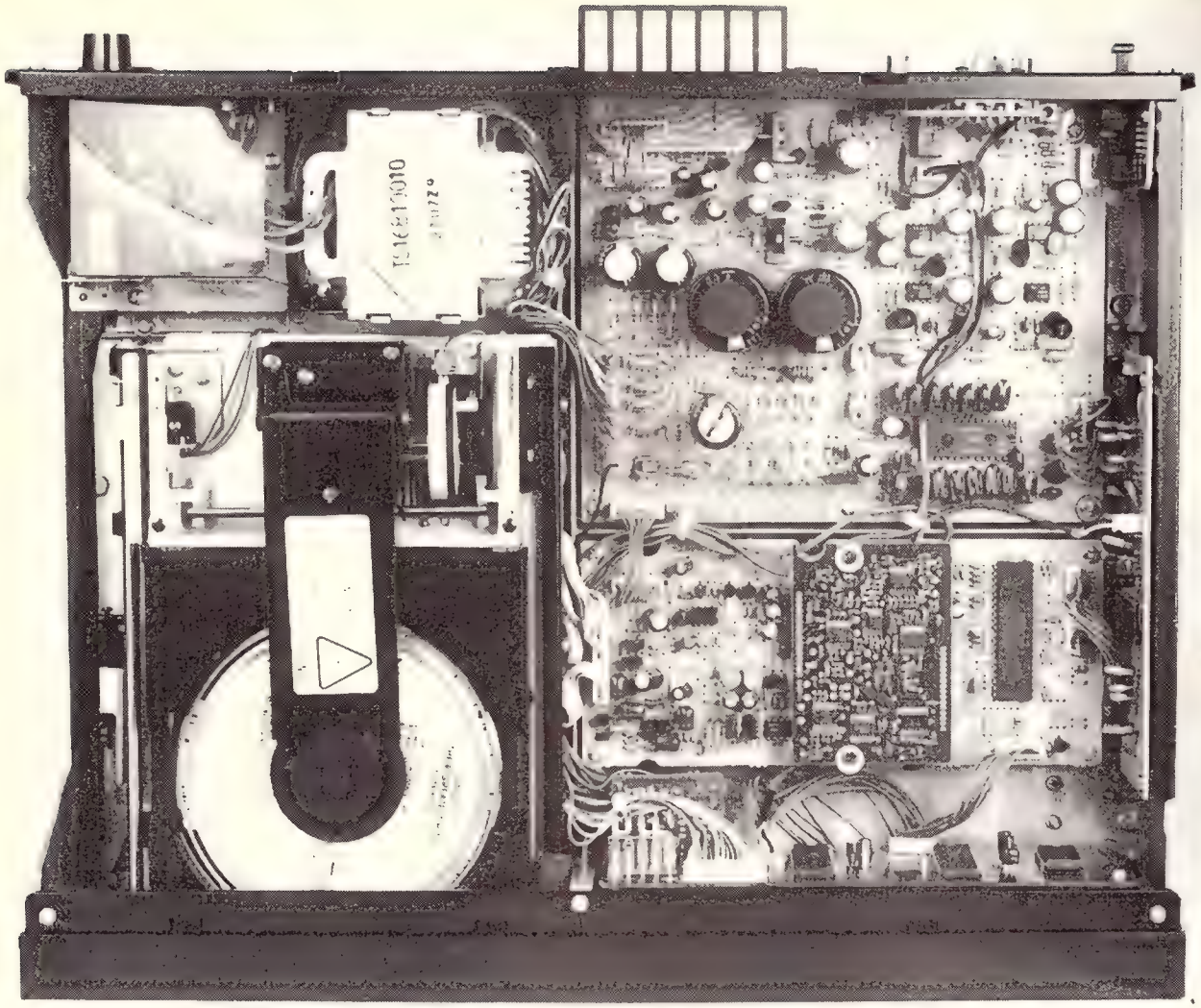
We'll attempt to tell you something of the physical attributes of the machine but you really need to have it demonstrated "in the flesh" to fully appreciate it.

At first it does not look all that different from other CD players. It is largish but not overly so and since so many CD players are black these days it does not really stand out as being really different; quite the opposite in fact. It is unobtrusive. It has very few controls visible on its front panel.

Turn it on though and it starts to look more the part. Its display panel lights in a very subtle blue (it's a vacuum fluorescent display) with a large pair of digits for track number and then smaller digits to show index numbering and elapsed time in minutes and seconds. There is also a line of very small digits which show the number of tracks on a disc (up to 24) and those that have been played. What we like about this display is that it is bright enough without being at all gaudy.

Press a very discreet open/close button and the disc drawer slides out quickly and smoothly. So many CD players give a poor impression at this stage. The drawer either makes graunching noises, or is too slow or is jerky. None of that with the CD-94.

Once the disc is dropped onto the



Inside the rigid diecast aluminium chassis of the CD94: note the generous transformer and all the capacitors which are specially made for Marantz. The player is particularly immune to shock and vibration, a legacy of the comprehensive error correction circuitry and the rigid construction.

platform, you can either nudge the drawer to make it withdraw or you can push the open/close button to achieve the same result. Good. This is a most desirable feature since not a few players can be jammed or damaged if the CD drawer is physically pushed home.

The only other controls visible on the front panel are the two large buttons to the right of the display panel for play/replay and pause/stop, and three small buttons below the display for FTS (favourite track selection) and track selection (forward/reverse). That may not seem like enough until you lightly press the lower part of the front panel. It then drops open smoothly (damped by a dashpot) to reveal a whole array of controls to enable you to make the machine do just about anything.

Paradoxically though, most users will probably never use these controls because, as far as we were able to determine, it can all be done with the infrared remote control.

Playing features

The CD-94 has all the playing features of most compact disc machines and a lot more besides. One of these is shuffle play. Instead of playing the disc through from start to finish, you can press "shuffle" and have the tracks played in random order. This can be a pleasant change when playing anything except classical music.

Another unusual facility on the CD-94 is "FTS" which stands for favourite track selection. This enables you to program the machine to play selected tracks on a compact disc and omit the others. Once you have programmed the machine for a particular disc it will always remember it. Thereafter, as soon as you feed the disc into the machine, it shows FTS on the display and you can then play the programmed selections by pushing the FTS button on the front panel or on the remote control.

Depending on how you use it, the Marantz can store a hundred or more compact disc 'favourite track selections'. For example, 155 discs can be programmed to play an average of five tracks each. In some ways, we would prefer to think of this facility as the "disliked track non-selection" — you can program the machine to omit those tracks you hate. Good idea?

THe CD-94 also has "Index" play whereby you can program or select musical passages to be played by

The lower part of the front panel drops down to reveal an impressive array of control buttons for programming. There is also a headphone socket with its own level control. A nice touch is the gold plating on the ten track selection buttons.

their index number. These are generally not used on pop music discs but are frequently used to identify movements within classical pieces.

Another facility is "AMS" or automatic music selection. This goes through and plays the first ten seconds of every track.

Repeat play is also featured, a common facility on CD players, but the Marantz also gives a similar facility with the Play/Replay. More often than not, pushing the Play button while play is in progress makes the machine move to the next track. On the CD-94 though, pushing the Play button makes it restart the same track and it does it almost instantaneously.

Response times on the CD-94 are particularly fast. It can usually access and start playing any track on a disc within two or three seconds, and often much less. The worst case, going from the first track to the last of a 25-track disc, takes four seconds flat!

Another feature which sets this machine apart from others is the provision of digital and optical fibre outputs on the rear panel. This is principally to allow it to be used with Marantz's special CDA-94 Digital-to-Analog Converter. This latter is a high precision multi-purpose unit which automatically adjusts its sampling frequency to suit the selected input: 44.1kHz for compact disc, 48kHz for the new DAT (digital audio tape) machines, and 32kHz for the anticipated satellite broadcast audio.

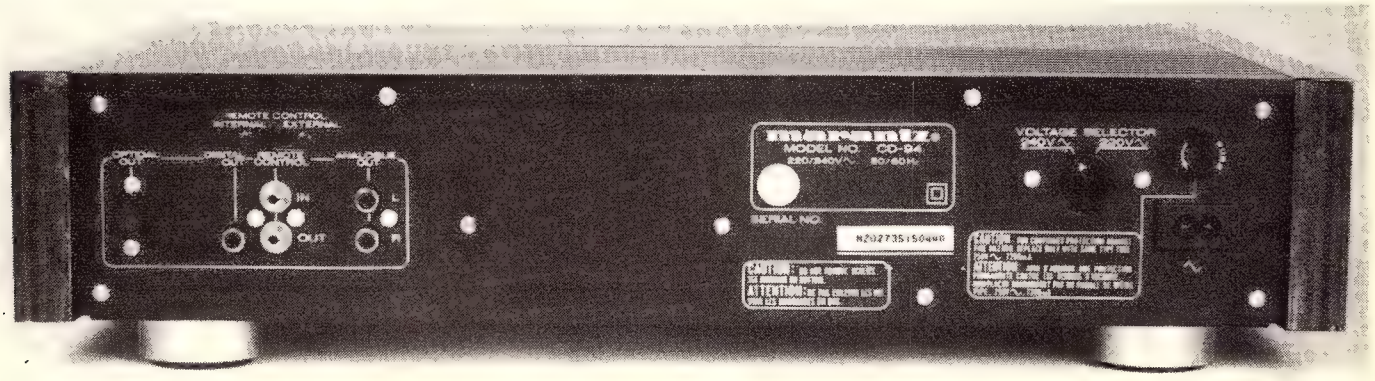
Removing the highly polished timber end pieces and the heavy aluminium lid of the case reveals another big difference with the CD-94 machine. At a time when other machines are going to all plastic construction and weighing only about 5 or 6kg, the Marantz has a very rigid diecast aluminium chassis and a diecast chassis for the player mechanism too. All up weight is 10.3kg.

The internal circuitry is beautifully laid out and uses analog componentry unique to Marantz. This includes the large Elna electrolytic capacitors with ceramic filling and the damped copper styrol (polystyrene) capacitors in the Bessel output filter stages. The capacitor leads are also tinned oxygen-free copper instead of the usual tinned mild steel leads, a feature which Ken Ishiwata claims is important to sound quality.

A relatively large mains transformer is used, considering the low nominal power consumption of 30 watts. The machine is double-insulated and we are glad to report that the mains wiring is of a much higher standard than a lot of equipment which sports the "double insulation" symbol. A sheathed two-core mains flex is used, which is as it should be.

16-bit dual D-A converters

Marantz uses the new Philips dual 16-bit D-A (digital-to-analog) converters with four times oversampling. The beauty of this system, apart from much improved linearity, signal-to-noise ratio, separation and all that, is that it allows a digital filter to remove the 176.4kHz digital residual left over



The CD-94 has digital and optical outputs as well as the normal analog outputs. There are two additional sockets for use with the Marantz bus system.

after conversion. A third order (18dB/octave) Bessel filter takes care of the remainder of the audio filtering.

This is better than typical machines which use a very sharp "brick wall" filter to remove the residual digital artefacts which inevitably results in ripples (ie, small deviations) in the audio passband.

Testing

Our first objective tests of the CD-94 involved its tracking performance and error correction. We used the Philips No 4A defect disc and naturally it passed all tests without so much as a murmur. Then we fed it a badly scratched disc which many players refuse to load let alone play.

Here the Marantz did very well and probably better than any other player we have come across. It played all but two tracks and even with these two, which are probably unplayable by any machine, it made a fair attempt before the laser pickup was thrown completely out and the machine came to a stop.

The machine was commendably immune to shocks and vibration. Short of pounding on it with your fist, it is very difficult to make it mistrack.

Without doubt though, the most impressive test results involved measurement of the frequency response. Marantz claim a frequency response from 2Hz to 20kHz within ± 0.01dB. When I first read this spec I did not believe it. It would be an unprecedented degree of precision for any piece of electronic equipment, audio or otherwise.

Subsequent checking proved that the spec is genuine although I still find it hard to believe. Up till this time, the tightest tolerance we have seen for any piece of electronic equipment has been ± 0.1dB.

We knew darn well that there was no piece of measuring gear currently available (maybe in Standard labs there are) which would verify the spec. But we went ahead and measured the frequency response anyhow.

It was uncanny, watching the millivoltmeter pointer come up to exactly the same reference point for every frequency between 20Hz and 20kHz. Clearly, the CD94 was far better than the millivoltmeter.

The remote control duplicates all the facilities on the player. Very fast response times are a feature of the machine.

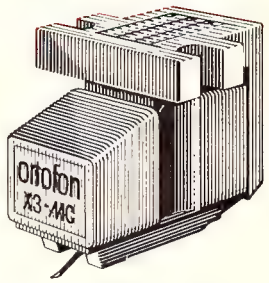
Marantz quote similarly ambitious figures for signal-to-noise ratio, separation between channels and total harmonic distortion. S/N ratio is quoted as better than 104dB, channel separation at better than 100dB and harmonic distortion as better than .0015% at 1kHz and 0dB. These are truly excellent figures.

Unfortunately, we were not able to verify them as we presently lack a suitable filter to remove residual 44.1kHz signal. In the CD-94, residual 44.1kHz is at a level of about −70dB and this masks signals which are much lower in level. This is a consequence of not using a "brickwall" filter, as we mentioned above. Based on the performance tests we were able to carry out, we have no reason at all to doubt the machine easily complies with its specifications.

I would go further than that. Of all the machines I have tested or used so far, I would have to rate the Marantz CD-94 as the best overall. It is a delightful machine to use and to listen to. I'd love to own it.

For such a top-rating machine, it is something of a bargain. Recommended retail price is $1699.00. For further information, contact Marantz (Australia) Pty Ltd on (02) 742 8322. sc

Three better from the Best.



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Hi-Fi News & Record Review, January 1987.

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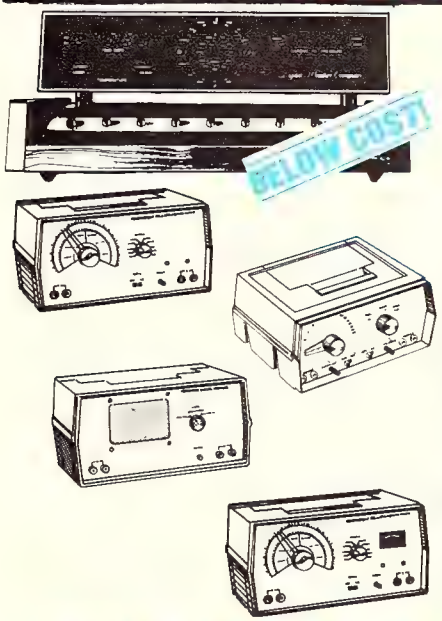

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By JOHN CLARKE & LEO SIMPSON

Sooner or later, every electronics enthusiast needs a DC power supply. They used to get by with a variable supply giving up to 15 volts or so at around 500 milliamps but today's circuits using op amps, memory and logic devices need a lot more than that. For op amps you need balanced positive and negative supplies of ± 15V while some memory chips such as EPROMs need ± 5V.

The problem with designing a power supply for the enthusiast or technican is that it is easy to get carried away with fancy features that are seldom used. The end result is an expensive supply that no one can afford. So we at SILICON CHIP have put our heads together on this project to produce a supply which has good performance and features while keeping the cost within bounds.

What are the big cost items in a power supply? That was the question we asked ourselves as we set out to design this supply. The big cost items are the transformer, meter, case, filter capacitors and printed circuit board. We could not eliminate any of these components in a self-contained power supply so we selected them very carefully to optimise the performance versus price ratio.

For example, we selected a transformer with a centre-tapped 30V winding rated at one amp. This was much cheaper than a centre-tapped 44V 1.5-amp transformer that we would have selected as first choice if price was not so important. But we had to admit that the times when enthusiasts want high currents are fairly rare.

By picking the smaller transformer, we greatly cut down the power dissipation in the circuit and thereby reduced the heatsinking requirements, the size of the case and the cost of the filter capacitors and regulators, all for very little reduction in overall utility of the supply. We also saved money by using a smaller meter, smaller rectifier diodes and so on.

The end result is a compact power supply which will serve the needs of the vast majority of electronic enthusiasts and technicians. It will become another in a growing list of SILICON CHIP test equipment.

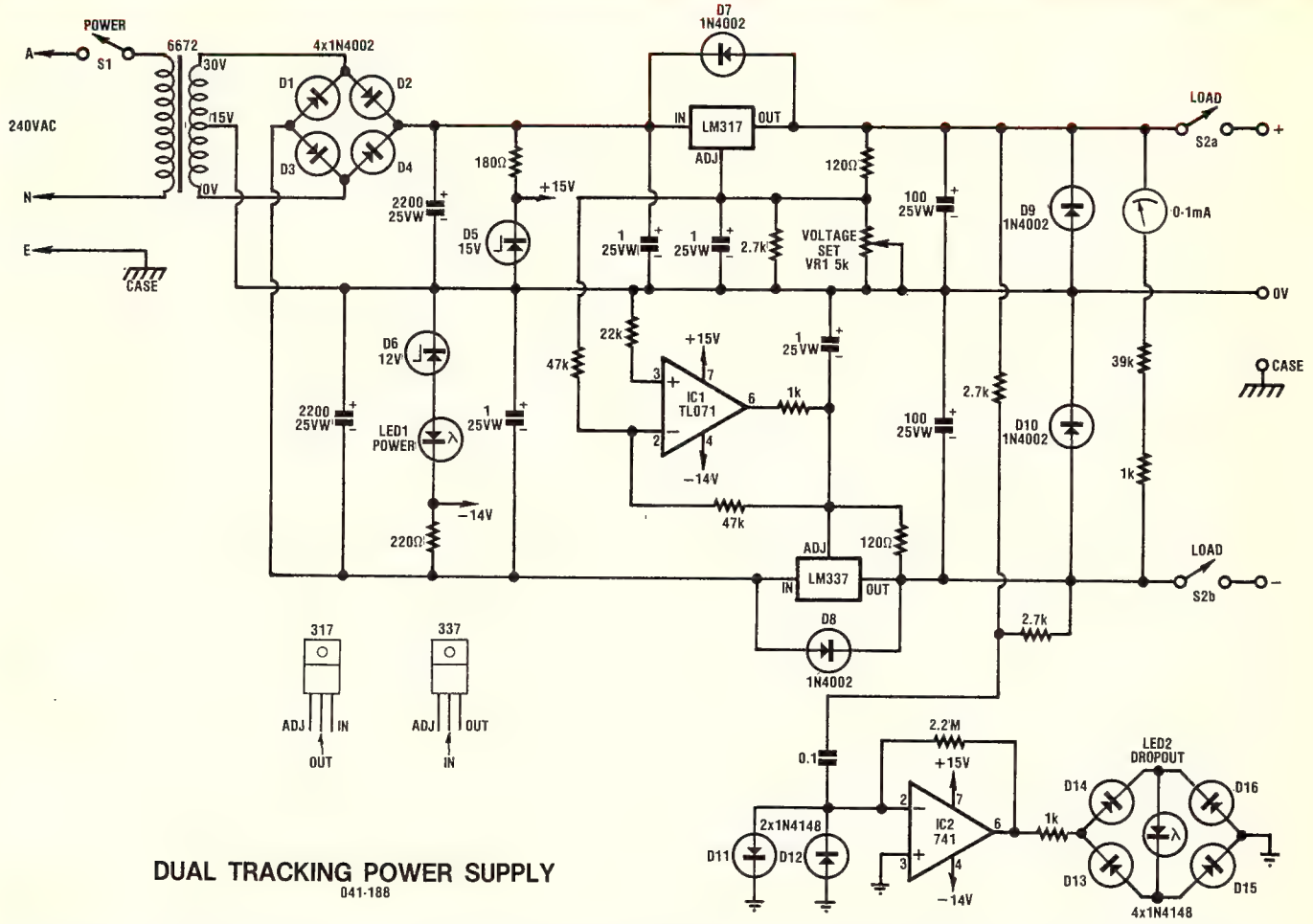


Fig.2: the circuit uses a 30V 1A transformer to drive a bridge rectifier and two adjustable 3-terminal regulators. IC1 inverts the control voltage provided by VR1 to drive the LM337. IC2 monitors the output ripple to provide drop-out indication.

The SILICON CHIP power supply has tracking positive and negative DC outputs adjustable from ± 1.2V to ± 18.5V. Both supply rails are protected against short circuits and

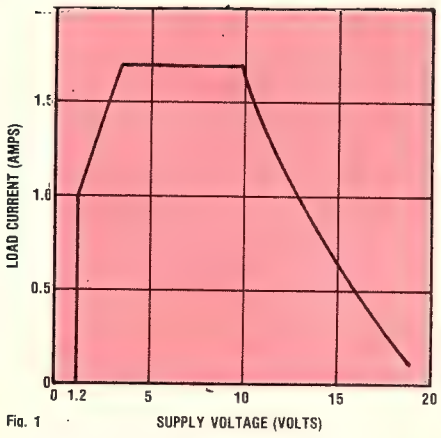


Fig.1: this graph plots the maximum output current for voltage settings between ± 1.2V and ± 18V.

voltages generated by external loads.

Maximum load current is 1.7A between ± 3V and ± 10V. When the supply stops regulating, a LED indicator lights.

You can use the power supply in the conventional way to provide balanced positive and negative rails, or you can take the output from between the positive and negative output teminals and thereby get more than 36 volts DC output. The circuit is fully floating (ie, not tied to mains earth) and so the output can be referenced to earth via the positive, negative or 0V rail.

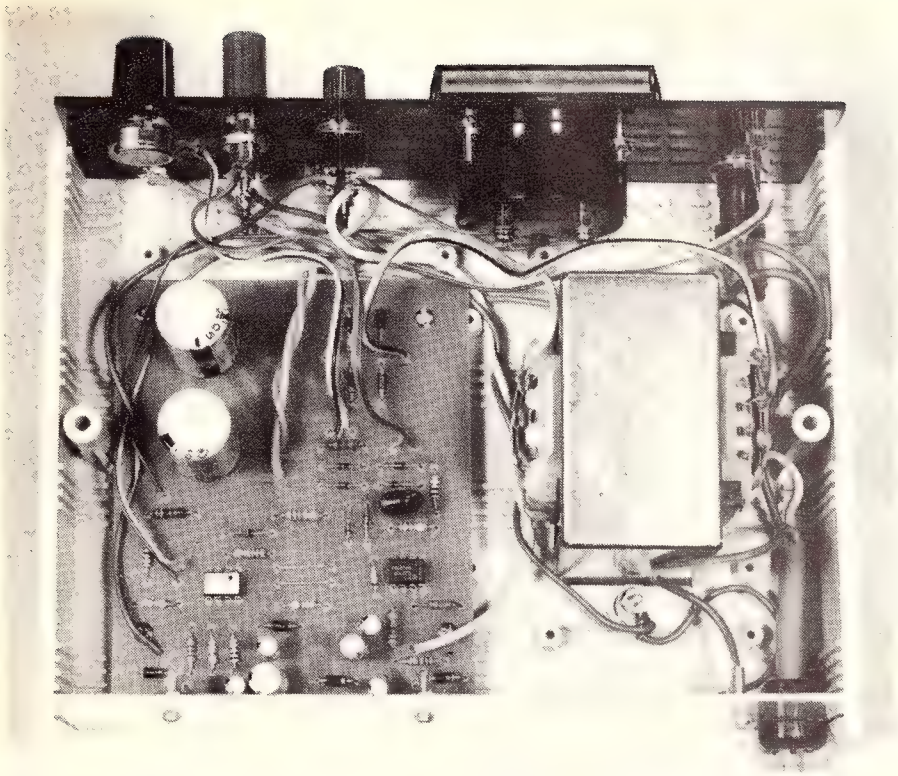
What will it do?

Fig.1 shows the maximum output current available for voltage settings between ± 1.2 volts and ± 18 volts DC with the positive and negative rails loaded. Up to 1.7 amps is available for settings between ± 3 and ± 10V. Above 10V the available current reduces, to 200 milliamps at ± 18 volts.

Remember that this performance applies with both the positive and negative rails loaded, so that by taking the output between the positive and negative rails, you get get up to 1.7 amps at 20 volts and up to 200 milliamps at 36 volts.

Line regulation is within ± 5mV of a given output voltage setting for mains input variation between 220VAC and 260VAC. Load regulation at 1.7 amps is within 100mV at a setting of 9 volts; ie, close to 1%. Ripple output (ie, 100Hz hum and noise superimposed on the DC rails) is less than 1mV peak-to-peak for load currents up to one amp. These are excellent figures. Dinkum.

Note that the actual maximum



The supply is very easy to wire but you should take extra care with the mains wiring. Use a cord-grip grommet to secure the mains cord.

available current from the power supply will depend on the temperature of the heatsink and the amount of power being dissipated in the regulator(s) for a given output setting.

Circuit details

Fig.2 shows the complete circuit. As already noted, it is based on a 30V centre-tapped 1A power transformer, Arlec 6672A or equivalent. Diodes D1 to D4 are connected as a bridge rectifier which, combined with the two 2200μF filter capacitors, give plus and minus DC rails of about 21 volts.

These unregulated DC rails are fed to LM317 and LM337 3-terminal regulators to provide the adjustable plus and minus supply outputs respectively. We'll briefly explain how these regulators work before going on with the rest of the circuit description.

The regulators are designed to give 1.25V between their output and adjust terminals. With this in mind, and the fact that the current flowing out of their ADJ (stands for ADJust) terminal is negligible, it is easy to design a variable regulated

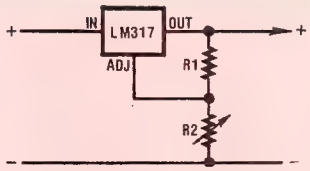


Fig.3: operating principle of the LM317 3-terminal regulator. R1 and R2 set the output voltage (see text).

supply. The circuit of Fig.3 demonstrates their operating principle.

Two resistors are used to set the output voltage in the circuit of Fig.3. R1 is fixed while R2 is variable. Since the voltage between the OUT and ADJ terminals is fixed at 1.25V, the current through R1 and R2 is also fixed. This gives a simple formula for the output voltage as follows:

$$Vout = 1.25(1 + R2/R1)$$

In our circuit R1 is 120Ω while R2 is made up of of a 2.7kΩ resistor in parallel with VR1, a 5kΩ potentiometer. The maximum effective value of R2 is thus 1.75kΩ and the theoretical output voltage range is therefore between 1.25 volts and 19.5 volts. However, the unregulated DC voltage fed into the regulators is normally not quite high enough to enable 19.5 volts output to be delivered.

That explains the circuit as far as the positive regulator (LM317) is concerned but what about the negative regulator. It has an operational amplifier connected to its ADJ terminal instead of a variable resistor. What giveth?

The idea of the op amp is to provide a mirror of the voltage at the ADJ terminal of the positive regulator. So if the ADJ voltage at the positive regulator is + 10 volts, the op amp will produce an output of – 10 volts by virtue of the fact that it is connected as a unity gain inverting amplifier. So IC1 ensures that the negative regulator always tracks with the positive regulator.

The 120Ω resistor between the ADJ terminal and output of the LM337 is there for two reasons: first, to give the required minimum load for the regulator, and second to set a load current flow into IC1. This load current of 10.4 milliamps impresses a voltage drop of 10.4V across the 1kΩ resistor at the output of IC1. This allows the op amp to drive the ADJ terminal of the LM337 regulator to – 17.3 volts in spite of the fact that the negative supply rail to IC1 is only – 14 volts.

The supply rails for IC1 are provided by zener diodes D5 for the positive line and D6 in series with LED 1 for the negative line.

Diodes D7, D8, D9 and D10 protect the regulators from reverse voltages which may be generated by capacitive or inductive loads connected across the outputs.

Drop-out indicator

When the regulators are working as designed, the ripple voltage superimposed on the DC rails will be very low. However, if the current drain is higher than the regulator can supply while still maintaining about 2 volts between its input and output terminals, the ripple voltage will suddenly become quite high. The output voltage will fall rapidly if even more current is called for and the ripple will go even higher.

When this condition is beginning to occur you may have no idea that it is happening. You need a visible

PARTS LIST

1 plastic instrument case, 205 x 159 x 68mm
1 PCB, code SC041-188, 112 x 92mm
1 Scotchcal front panel, 190 x 60mm
1 meter scale display, 52 x 43mm
1 6672 30V, 1A transformer
1 single-pole pushbutton mains switch
1 DPDT mini toggle switch
4 banana panel terminals (blue, white, red and green)
1 5kΩ potentiometer
1 knob
1 mains cord and plug
1 cord clamp grommet
2 solder lugs
1 aluminium panel, 196 x 64mm x 1.5mm
2 TO-220 insulating kits (mica washer and bush)
1 MU45 panel meter, 0-1mA movement

Semiconductors

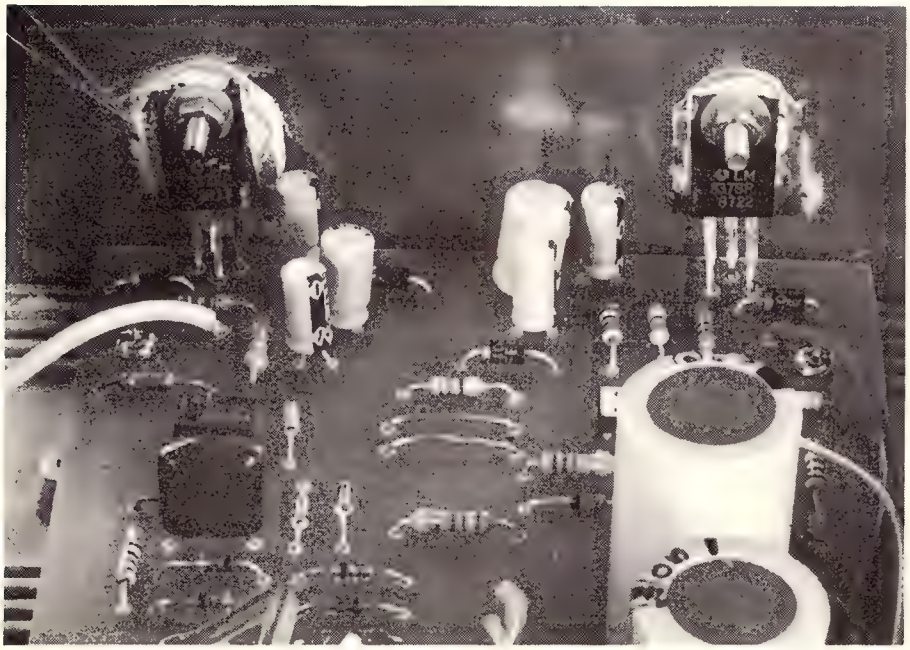
1 LM317T positive adjustable 3-terminal regulator
1 LM337T negative adjustable 3-terminal regulator
1 TL071, LF351 FET input op amp
1 741 op amp
9 1N4002 or equivalent 1A diodes
6 1N914, 1N4148 small signal diodes
1 12V 1W zener
1 15V 1W zener
2 5mm red LEDs

Capacitors

2 2200μF 25VW PC electrolytic
2 100μF 25VW PC electrolytic
4 1μF 25VW PC electrolytic
1 0.1μF metallised polyester

Resistors (5%, 0.25W)
1 x 2.2MΩ, 2 x 47kΩ, 1 x 39kΩ, 1 x 22kΩ, 3 x 2.7kΩ, 3 x 1kΩ, 1 x 220Ω, 1 x 180Ω, 2 x 120Ω

Miscellaneous
Solder, hookup wire, insulating sleeving, screws, nuts, self-tapping screws etc.



Close-up view showing how the 3-terminal regulators are mounted (see also Fig.5). Use your multimeter to check that the metal tabs are isolated from chassis.

indicator. Hence, we have designed a drop-out indicator using IC2.

IC2 is connected as an inverting amplifier with a gain of about 800. It monitors both the positive and negative regulators via 2.7kΩ resistors and a 0.1μF capacitor. Diodes D11 and D12 limit any noise or ripple signal level to a maximum of ±0.7V.

The amplified ripple at the output of IC2 is fed to a full wave rectifier consisting of D13 to D16 via a 1kΩ limiting resistor, to feed a light emitting diode, LED 2. The LED begins to glow when the ripple at one of the regulator outputs becomes greater than about 4mV peak-to-peak. At about 19mV p-p ripple the LED is fully alight.

A 1mA meter monitors the output voltage via the 1kΩ and 39kΩ resistors. This gives it a full-scale reading of 20 volts.

Putting it together

The supply is housed in a standard plastic instrument case measuring 205 x 159 x 68mm (Altronics Cat. No. H-0480 or equivalent). All the circuit with the exception of LEDs, switches and the pot, is accommodated on a printed circuit board measuring 112 x 92mm (coded SC041-188). Both 3-terminal regulators are bolted to the rear metal panel of the case for heatsinking.

You can start assembly by checking the copper pattern of the board for any breaks or shorts in the tracks. Compare it with the pattern published in this article.

With that done, you can install all the small parts on the printed board. These include the resistors, diodes, links, small capacitors and the two op amps. Make sure that the ICs and diodes are correctly oriented before soldering them into place. Note that the two ICs face in the same direction. Use the wiring diagram of Fig. 4 to check each stage of assembly.

Next, install the two 2500μF capacitors and the two 3-terminal regulators. The regulators should be mounted so that their bodies are about 10mm clear of the board, to allow them to be easily bolted to the back panel of the case.

We recommend the use of PC pins for all external wiring from the

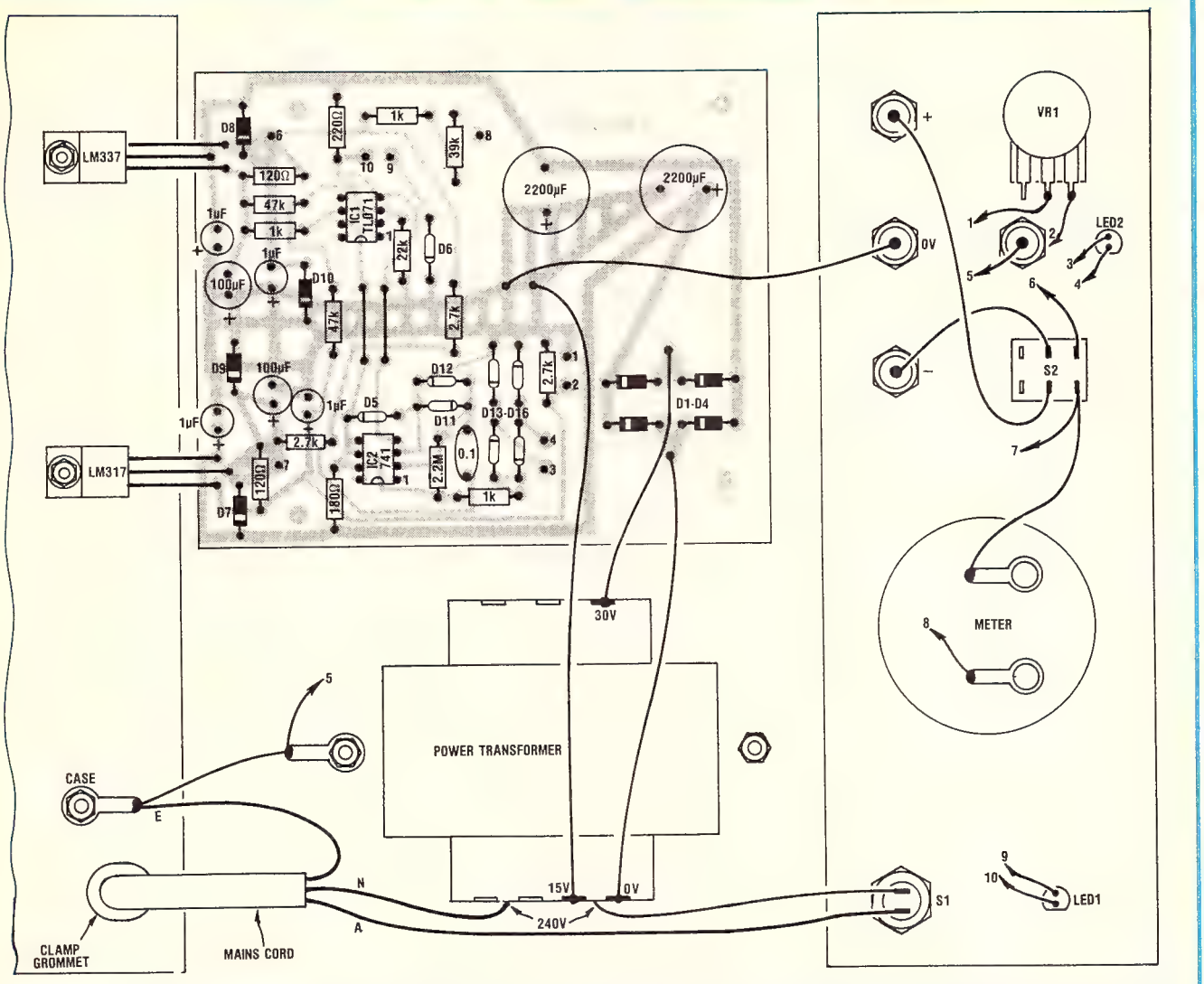


Fig.4: follow this wiring diagram carefully and your supply should work first time. Use medium-duty 24 x 0.2mm cable for connections between the PCB and transformer, and to the output terminals and Load switch (see text).

board. They simplify connecting it up and give easy test points when checking voltages.

The completed printed board is supported on four of the integral plastic standoffs on the base of the case and secured with self-tapping screws. The transformer must be mounted directly onto the base of the case. To do this, two of the standoffs will have to be removed or drilled out and holes drilled for 3mm roundhead or countersunk screws. Use lockwashers under the two nuts.

Note that the mains earth wire is terminated to a solder lug on the rear metal panel of the case and thence to a solder lug secured by one of the transformer mounting screws. The earth wire also goes to the green GND terminal on the front panel.

When the printed board has been installed, slide the metal rear panel into the case and mark the mounting hole positions for the two regulators. The mounting holes should be drilled for 2.5mm screws. Fig.5 shows the mounting details for the two regulators. Note that a mica washer and insulating bush must be used to isolate each device from the metal panel.

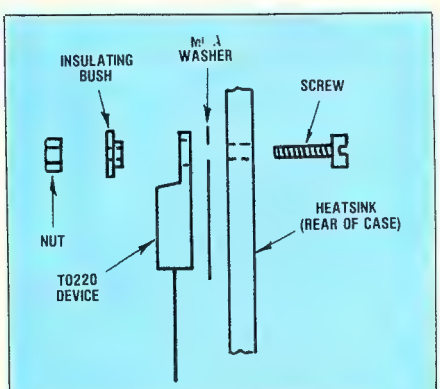


Fig.5: mounting details for the two 3-terminal regulators.

Deburr de burrs

Before securing the regulators, make sure that the mounting holes are free of burrs. Lightly smear heatsink compound on the regulator heatsink surfaces and the mating areas on the metal panel. Then screw the two regulators to the panel as shown in Fig.5.

You should then switch your multimeter to a low Ohms range and use it to check that the metal

tabs of regulators are both isolated from the metal panel.

You can then work on the front panel. Kitset buyers can expect that they will be supplied with a screen-printed precut panel but if you're working from scratch you will probably have to make or purchase a Scotchcal panel. The artwork can be used as a drilling template for the front panel. The meter is supplied with its own template for the four mounting screws and 46mm diameter cutout.

This latter hole can be made by drilling a series of small holes just inside the circumference of the marked circle and then filing the resulting cutout to a smooth circle.

Having drilled all the holes, you can affix the artwork to the front panel. The material covering the holes is then removed using a Stanley utility knife.

Now the front panel hardware can be mounted. In complete kits, a new scale should be supplied for the meter. This is easily fitted. Just unclip the meter bezel, undo two screws, remove the old panel and replace it with the new and then reassemble. Alternatively, you can remove the existing scale, erase the numbering and re-do it with Letraset.

Complete the wiring by following

What's a dual supply?

"Wotsa dual tracking power supply anyhow and why would I want one?" we hear you ask, in your ardent quest for knowledge.

The word *dual* refers to the fact that this power supply has two supply rails, one positive and the other negative. The word *tracking* refers to the fact that when you adjust the positive supply, the negative supply automatically follows so that it has the same absolute value. So if you set the positive output to plus 10 volts DC, the negative rail will be very close to minus 10 volts.

That's what you'd expect, isn't it?

Fig.4. Connecting wires to the potentiometer, the two LEDs and the meter can be light-duty hook-up wire but the remaining wiring should use heavier wire, such as 24 x 0.2mm insulated cable.

The 3-core mains cable should have its outer insulation layer removed for a length of about 10cm so that the active lead can reach the mains switch on the front panel. The mains cord can then be secured to the rear panel using a cord-grip grommet.

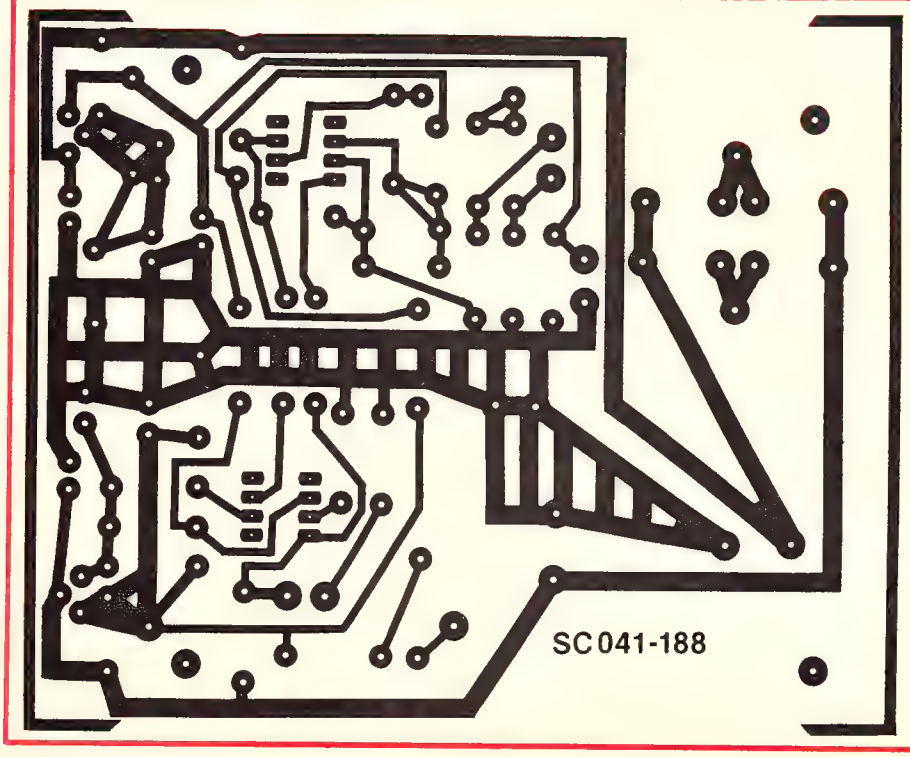
The neutral lead is terminated directly at the transformer, as is the other lead from the mains switch. Both the mains termination on the transformer and the mains switch itself should be sleeved with plastic tubing to avoid the possibility of accidental shock.

When all the wiring is complete you should check your work carefully against Fig.4 and Fig.2 (the circuit diagram). With that done, you can apply power and check the voltages. The unregulated voltages to the input of the two regulators should be about ± 21 volts, while supplies to the two op amps should be + 15V at pin 7 and − 14V at pin 4.

Now check that the positive and negative supply rails can be varied over the range from below 1.5V to above 18V and that the two supplies track each other within ± 100mV.

The dropout indicator can be checked for correct operation by connecting a 22Ω resistor across either the positive or negative supply. Now, when the output voltage is wound up above 15 volts, the LED should light.

All that remains is to secure the lid of the case and your power supply is ready for work.



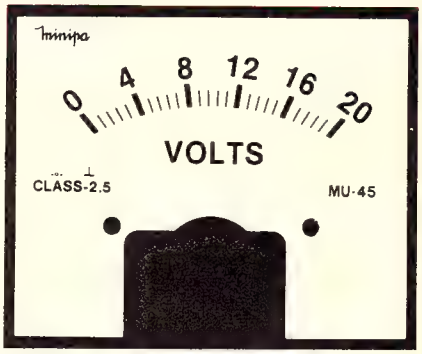


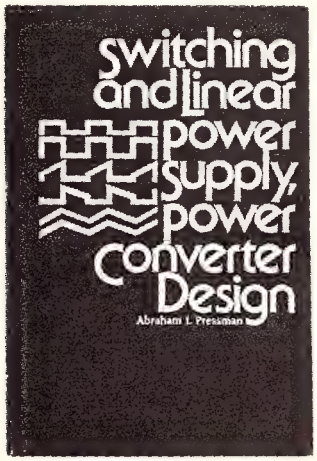
Fig.7: this full-size artwork should be used to replace the existing meter scale. The old artwork is removed by unclipping the meter bezel and undoing two small screws.

Fig.6 (left): this full-size reproduction of the PC pattern can be copied and used to etch your own PC board.

BOOKSHELF

Comprehensive text on power supplies

Switching and Linear Power Supply, Power Converter Design, by Abraham I. Pressman. Published 1977 by Hayden Book Co, Inc, Hasbrouck Heights, NJ. Hard covers, 160 x 235mm, 372 pages ISBN 0 8104 5847 0.



These days switching power supplies are becoming ever more widespread throughout electronics as efficiency, compactness and low heat dissipation become more desirable. For this reason alone the book is of considerable interest but it would be a mistake to regard it as just on switching power supplies. As the title suggests, there are also major portions devoted to the design of linear power supplies and power converters.

A brief explanation of these terms is in order before going on to review this text. Switching power supplies vary and maintain their output by rapidly switching on and off their main control element which these days is a high power transistor or transistors.

A linear power supply is one in which the output voltage is varied or maintained by continuously adjusting the main control element which again is a power transistor or group of transistors. Lastly, power converters are circuits which step up or down from a DC input voltage to provide one or more DC outputs. They usually consist of a high frequency transformer driven by switching transistors.

And now to our review: as far as the subject matter is concerned, this book is old. Published in 1977 and possibly written a year or two before that, it naturally misses out on all the developments in power supplies and electronics generally, that have taken place in the last twelve years or so.

That means that such things as 3-terminal regulators, gate turn-off thyristors, power Mosfets, CMOS logic circuits and Fet-input op amps don't get a mention. Nor is there any discussion at all on power control using silicon controlled rectifiers (SCRs) or Triacs and hardly a mention of 3-phase circuits.

Be that as it may, it is still a very worthwhile book, now in its seventh printing. I would regard it as one of the best overall texts on the subject of power supply design that I have come across.

There are nine chapters in all, starting with a chapter on basic voltage regulators and power converters. This has a good section on the design of zener diode and emitter follower regulators. An understanding of this topic is essential to anyone involved in power supply design.

Chapter two is basic square wave power converters and regulators while chapter three is on compound regulators.

Chapter four is an excellent dissertation on the subject of thermal design which is applicable to power amplifier design as well as power supplies. It discusses forced air cooling too.

Chapter five is another on fundamentals, this time on rectifier design using capacitive filters. This also contains a useful section on voltage multipliers, using diodes and filter capacitors.

Chapter six goes into the nitty-gritty on series pass regulators and includes sections on foldback current protection and crowbar overvoltage protection.

Chapter seven is on integrated circuit voltage regulators, mainly on the Fairchild μA723 although the National Semiconductor LM105 and Motorola MC1560/1561 are also covered.

Finally, chapter eight covers DC/DC converters while chapter nine covers switching regulators, both in considerable detail.

In summary, it's an oldie but a goodie. Our copy came from Jaycar Electronics.

Active filter design

Active Filter Design, by Carson Chen. Published 1982 by the Hayden Book Co, Inc, Hasbrouck Heights, NJ. Soft covers, 152 x 228mm, 133 pages. ISBN 0 8104 0959 3.

This small text is aimed at the engineer who wants a quick reference on the subject of active filters. It makes considerable use of mathematics to support the text, particularly S-parameters.

There are essentially six chapters, as follows: (1) Transfer Functions, Decibels and the Quality Factor; (2) Magnitude, Phase, Poles and Zeros; (3) Some Basic Transfer Functions; (4) Basic Filter Topologies; (5) Mathematical Approximations: Butterworth, Chebychev, Elliptic and Bessel; (6) Cascading, Normalisation, Frequency Transformation and Impedance Scaling.

It is by no means an easy text to read. For example, the sections on poles, zeros, normalisation and impedance scaling are unlikely to be understood by anyone who has not previously come up against these concepts.

In summary then, it is OK for the engineer or engineering student but anybody else can probably forget it. Out copy came from the publisher.

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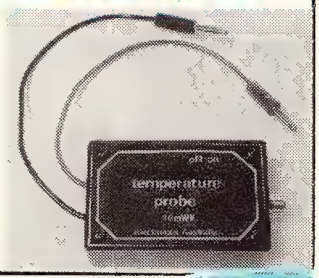

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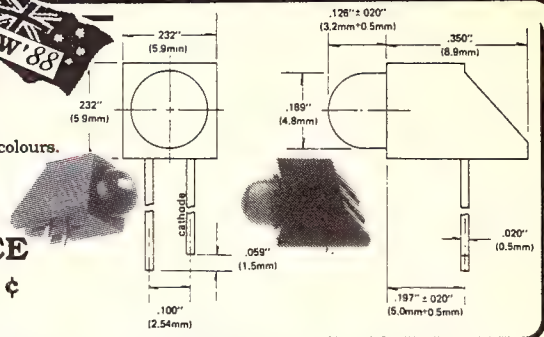

LED BAR GRAPH

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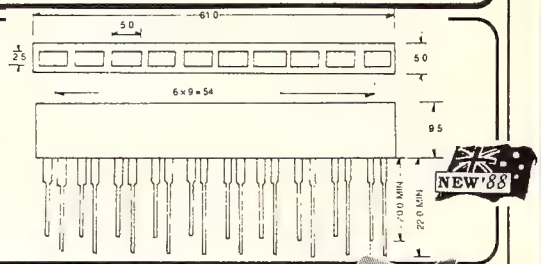

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The STD Bar for your telephone will be available sometime in January. It appeared in our catalogue but we were afraid to release it due to to the safety aspect of 000 emergency number. We have solved this problem, and the new model will allow emergency calls through on the 000 number, but will stop standard STD calls (except Tasmania). Cat. YT-6540

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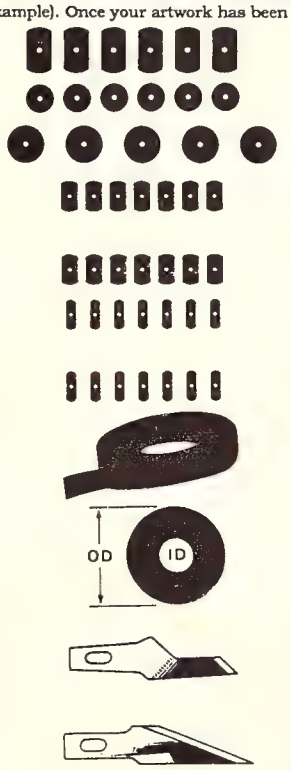

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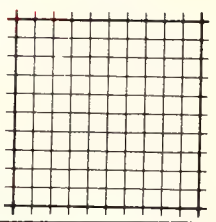

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JAYCAR JAYCAR JAYCAR

Build this superb

1GHz Digital Frequency Meter

This month, we complete construction of the 1GHz DFM and describe the calibration procedure. There's also a useful troubleshooting guide — just in case you strike trouble.

By STEVE PAYOR

Last month, we left off after describing the assembly of the two main printed circuit boards. The next step is to solder the two boards together at right angles.

To so this, carefully align the two boards, using the arrows at each end of the display PCB as a guide, and solder tack them in several places. Now inspect the assembly carefully and make any adjustments that may be necessary. When everything is correct, solder all the matching pads together to create a permanent assembly.

Finally, check that there are no solder bridges between adjacent pads. The meter is now ready for its first test.

Temporarily install an insulated link across the switch connections to the mains terminal block (the mains switch is installed later), then slot the counter module into the front of the case. Connect the power supply leads to the board with a multimeter set to measure DC current in the +5V lead. Plug in, switch on and verify that the current is between 300 and 500mA (depending on how many digits are lit).

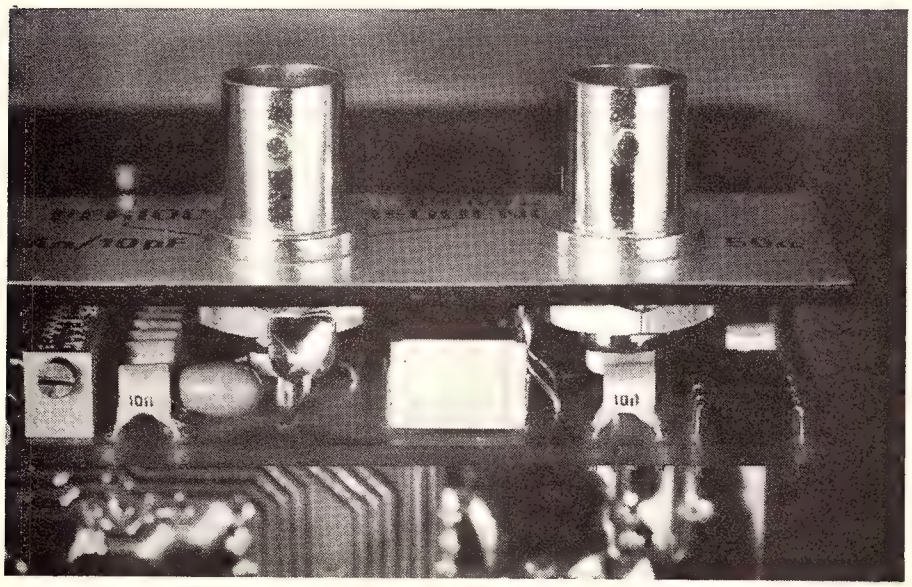
If all is well, try pressing the front panel buttons. On power up, the display should read .000kHz and the second Function LED should be lit (frequency to 10MHz). When the Range buttons are pressed, the leading zero on the display should be directly above the selected button, and the decimal point should be immediately to the left or right of the leading zero, depending on the setting of the Function pushbuttons.

The function indicator LEDs and the μsec and kHz light bars should change with the Function pushbuttons.

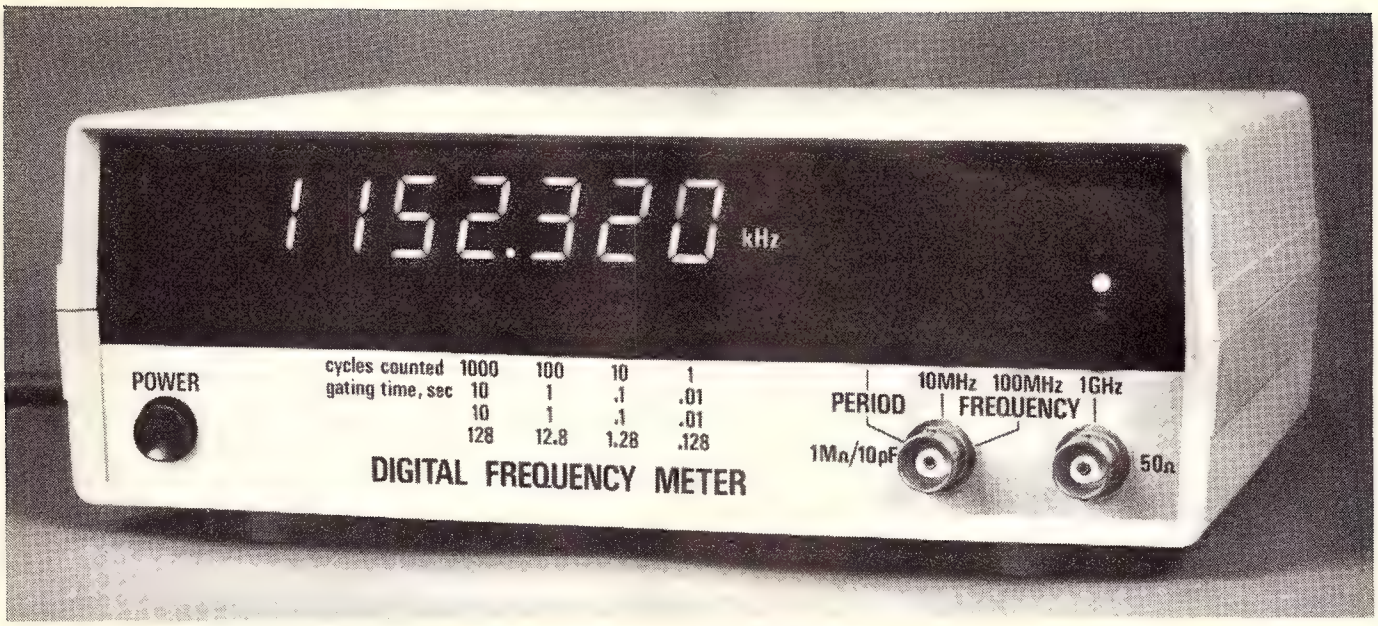
If you strike problems here, switch off immediately and check for wiring errors.

Assuming the power consumption of the counter module is within the specified limits, you can now go ahead and make the +5V supply permanent. Twist the supply leads together and trim them so that they are just long enough to reach the counter PCB.

The μsec and kHz transparencies can now be glued to the light bars. Use only water-based PVA glue (eg, Selleys "Aquadhere"). Only a tiny bead around the outside edge is re-



This close up view shows the mounting details for the two BNC sockets. Note that two earth links are soldered to the 50Ω input socket.



Above: the new 1GHz DFM is shown here displaying the frequency generated by the SAB6456 prescaler IC (see text).

quired. If you make a mess, clean up with a damp cotton bud and try again.

Testing the counter module

The counter module should rest comfortably in the second PCB slot from the front, leaving a 10mm clearance between the display PCB and the front panel. At this stage, you will find that the 1kΩ multiturn trimpot will be resting on one of the PCB guide rails, so carefully cut away the plastic at that point.

Do not drill a hole right through the plastic case, as this trimpot is not meant to be adjusted from the outside.

With the counter module and rear panel module in place, slip on the top half of the case, then turn the whole unit upside down. The bottom half of the case can now be removed to expose the underside of the counter and display PCBs.

Next, solder a shorting link across the 1MΩ input pads on the display PCB and plug a 1.7V red LED into the Molex pins at the test point. The anode of the LED should be connected to the +5V track, which is the thicker of the two. Switch on — with no signal input, the LED will either be on or off, depending on the state of the Schmitt trigger (IC2a).

If the LED is off, turn VR1 clockwise until it *just* comes on, or vice versa. Tapping VR1 with a metal screwdriver will inject enough noise to trip the Schmitt trigger, so keep the blade in steady contact (or use a plastic screwdriver).

Having found one of the trip points, slowly turn VR1 in the opposite direction, half a turn at a time, counting as you go. When the Schmitt trigger changes state again, you have found the other trigger point. On the prototype, the

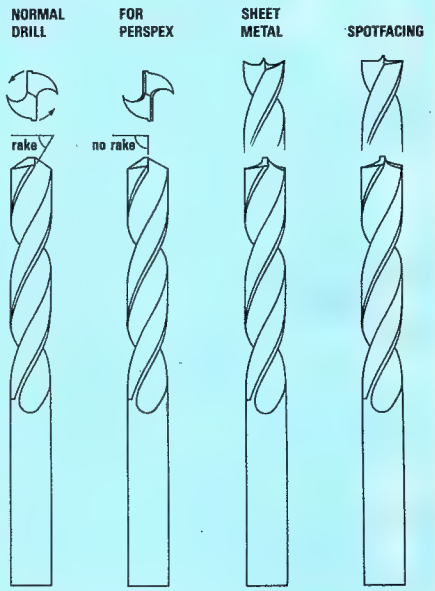
Hints on Drilling the Perspex Panel

The greatest hazard when drilling thin perspex sheet is the possibility that the drill will take one bite and shatter the panel.

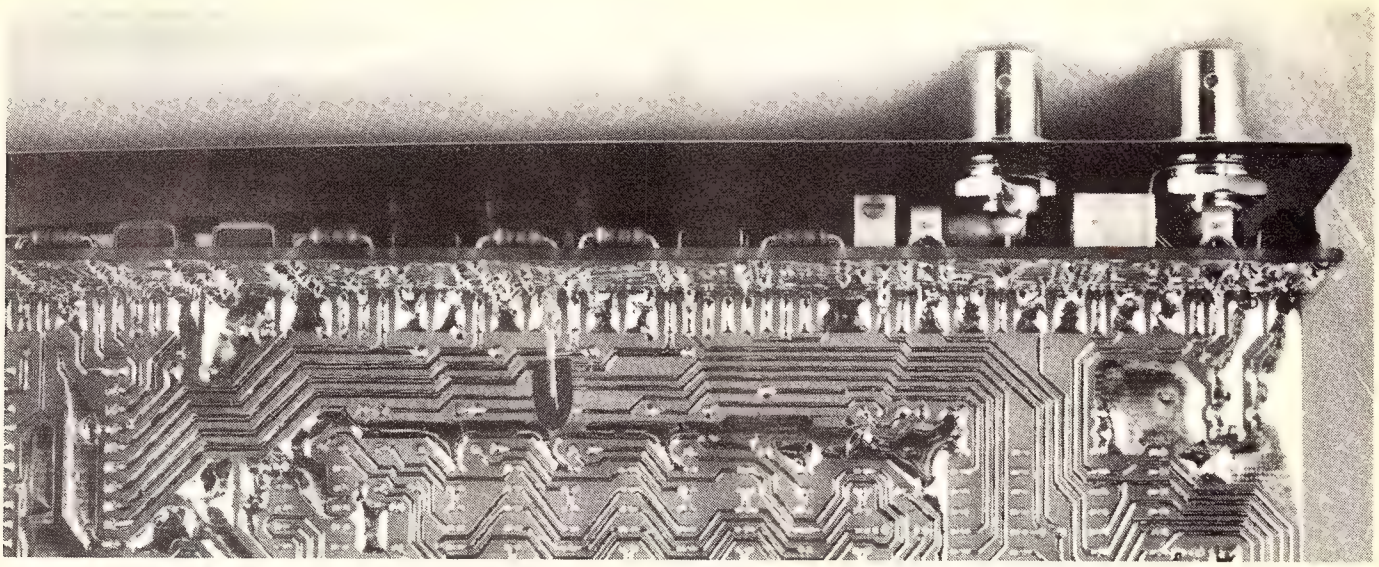
To avoid this problem, the drill should be as sharp as possible, for a clean finish, but the cutting edge should have no rake. Specifically, the leading edge should be at 90° to the cutting direction as shown below. It only takes a minute to convert a normal drill bit, using a grinder or pocket stone.

The other problem often encountered is a poor finish, caused by the drill overheating and melting the surrounding plastic. Again, keep the drill sharp.

There are two other styles of drill grinding which are useful when building a project like this. The W-shaped bit is for cutting clean, perfectly round holes in sheet metal. This drill actually punches out a thin disc at the end of the cut, leaving no burr on the far side. It is perfect for drilling ventilation holes in aluminium or thin sheet steel and will even cut a clean 12mm hole in tinplate. Using a normal drill for this job would leave you with a mess.



The spotfacing drill is similar, but the "wings" are straight instead of W-shaped, and less rake is used on the leading edge. This type of drill will soon get rid of any unwanted plastic pillars, cutting them flush with the inside of the case.



The 100MHz preamplifier circuitry is adjusted with a 1.7V red LED plugged into two Molex pins on the back of the display PCB.

range was five full turns. This is a convenient way of checking the DC gain of the amplifier circuitry — each turn is approximately 1mV.

Check the trip points once more, then set VR1 exactly half-way between them for maximum sensitivity.

Once VR1 has been set, remove the input short and the LED. Slip on the bottom of the case and turn the instrument right way up again. The instrument is now ready for its first frequency measurement.

Select a 1MΩ resistor and clip one lead short. Switch on and touch this lead to the 0.047μF input capacitor while holding the other lead in your fingers. The DFM should show a steady reading of .050kHz. Note: the 1MΩ resistor, in conjunction with the input capacitance, acts as a low-pass filter for the 50Hz signal picked up by your body capacitance from the mains wiring.

The ÷10 prescaler can now be checked by pressing the F3 button. The display should change to 0.05kHz (1s gating time).

Now switch to period mode. You should get a fluctuating reading of around 20,000μs (20ms). The reading will be constantly changing because the short-term stability of the mains is nowhere near as good as that of the crystal. Removing the signal source in Period mode will freeze the reading since the 7216A counter chip will be waiting for the required number of input cycles to be completed before it updates the display.

Checking the 1GHz range is easy. Press the F4 button and select the minimum gating time (R4). You should now have a rapidly updating reading of around 1.2GHz. This is because the SAB6456 prescaler oscillates at this frequency when no signal is present. Now press the R2 button and wait 12.8 seconds until the display updates. The leading "1" will now be in the overflow position, with the rest of the digits much the same as before.

The above procedure checks out virtually all of the functions of the DFM. If your unit passes all the above tests, you can be sure it's fully operational.

The front panel

The front panel artwork shows the drilling pattern for the panel. Red perspex is the material of choice and the colour to ask for is "Red 502". This is a deep ruby red colour which looks quite dark but transmits the wavelength of the red LEDs extremely well.

The thickness of the panel should be 2mm, with 1.6mm as the second choice. Unfortunately, these thicknesses are not universally available, although 3mm sheet is quite common and can be pressed into service if you have no other choice.

The 3mm sheet will fit in the wide gap between the front panel slot and the first PCB slot. The PCB should be moved to the third rearmost slot (don't forget to cut the relief for VR1). Provided none of the components are higher than the height of the 7-segment displays, everything will still fit.

If you go for this option, note that you will have to trim an extra 1mm from the top and bottom of the panel. The width remains the same.

Once the panel has been cut to size, the holes can be drilled to accept the switches and input sockets. This can be done by first taping the front panel artwork (or a copy) to the panel, then marking out the holes with a sharp scriber. Pilot drill all holes with a small PCB drill to start with, then progressively enlarge the holes, checking the centring as you go.

The final hole sizes are 9.5mm for the BNC sockets and 10-11mm for the pushbutton switches. You

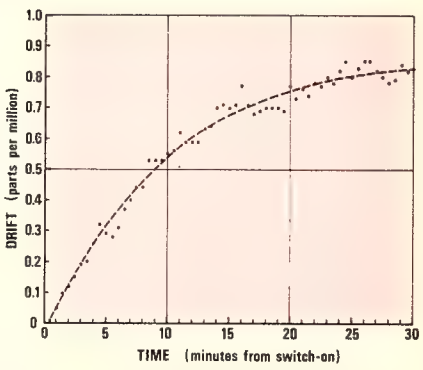
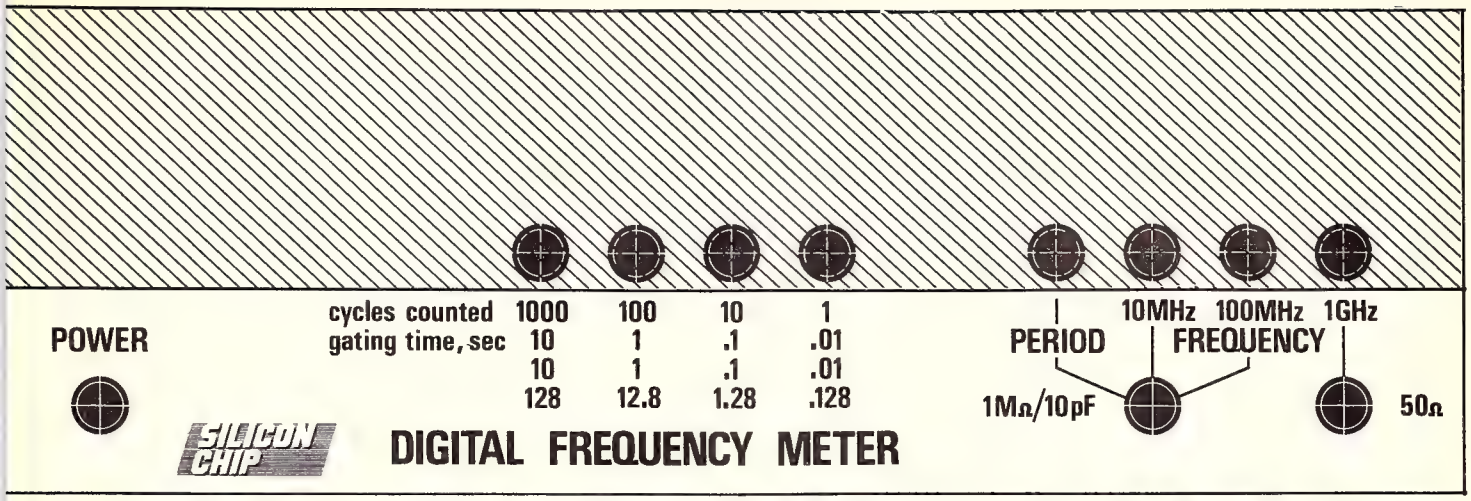
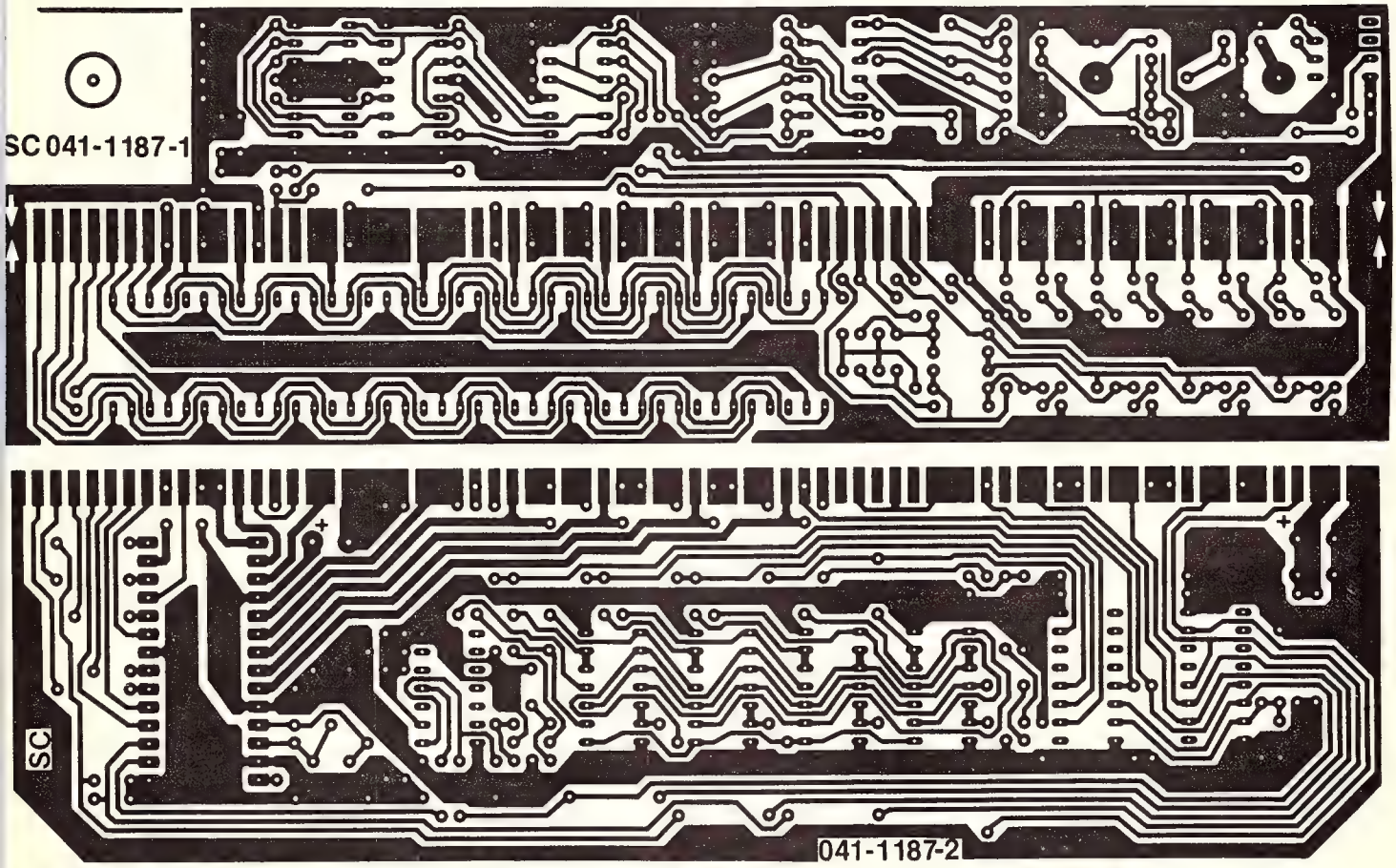
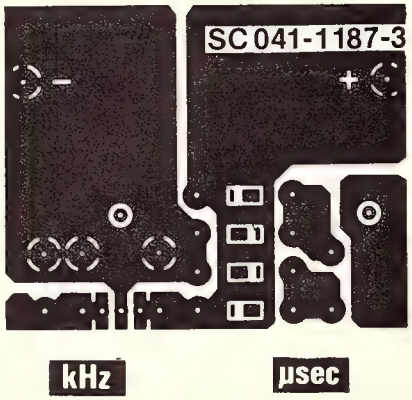


Fig.12: this graph plots the warm-up drift of one of the prototypes. The total drift is better than 1ppm.





Here are actual size artworks for the front panel, printed circuit boards, and kHz and μsec indicators.



may wish to ream the last mm or so of the pushbutton holes, particularly if the drill is not cutting evenly. Drilling thin Perspex is not an easy task, so we have included a panel on hints for drill sharpening for those readers who are not used to working with this material.

Because the inside edges of the pushbutton holes are visible, you may wish to polish them. Alternatively, blacken them with a marking pen.

Front panel assembly

Affix the Scotchcal label to the front panel, then cut out the three holes for the power switch and input sockets using a sharp utility knife. A light touch with a reamer will improve the appearance of the hole for the mains switch.

Troubleshooting the 1GHz DFM

Don't rush out and replace all the semiconductors if the counter module fails to work first go. The problem is almost certain to lie elsewhere unless you've done something silly, such as installing an IC or transistor back to front.

The first thing to check is that all the parts are in their correct positions and are correctly oriented. For example, the switches will not work if they are rotated 90°.

Next, check the copper side of the PCBs for soldering faults, such as bridges between the closely-spaced tracks around the IC pads. Another thing to look for is open circuit tracks, and these are most likely to occur where too large a hole has been drilled through an IC pad.

One area where soldering faults are both common and easily detected is in the multiplexed display. A short between segments is easily recognised from its effect on the display, as is an open circuit along one of the segment tracks.

Some constructors of previous DFM projects have experienced trouble in getting the 7216A's oscillator to start up. The symptoms are no display at all, or only one digit lit and very briefly at that. The problem usually occurs with very cheap crystals which have a large equivalent series resistance.

Calculations based on the minimum guaranteed gain of the CMOS inverter show that the oscillator will only work with a crystal having a series resistance of less than 80Ω and 20pF shunt capacitance, or 35Ω and 30pF nominal shunt capacitance.

If you are unlucky enough to have a crystal with excessive series resistance, the cure is fairly simple: use less capacitance to the +5V rail at pins 25 and 26 and maintain the correct shunt capacitance by installing a capacitor across the crystal.

For example, removing the 39pF capacitor and 40pF trimmer leaves the crystal with a shunt capacitance of about 3pF, so adding a 27pF capacitor between pins 25 and 26 will bring a 30pF crystal back to the correct frequency. The circuit will now tolerate a series resistance as high as 120Ω although the stability will no longer be quite as good.

Signal tracing

A pair of headphones and a multimeter are the best de-bugging aids you can have for this project.

Assuming the 10MHz oscillator is running, the 7216A should be putting out 500Hz signals on the digit and segment driver lines. You can verify this with the headphones. Use a 1kΩ-10kΩ resistor as a probe (to avoid loading the circuit and to protect the headphones), and listen to one of the digit driver outputs. A "spiky" 500Hz tone should be instantly recognisable, and all the digit drivers should sound the same.

The segment drivers will have the same pitch but a different timbre as the numbers on the display change.

Check that a similar 500Hz signal is also reaching the clock inputs of the 4024 and the 4017s. As a matter of interest, follow the

Mount the two BNC sockets and orient them so that the solder tags will fit between the parts on the display PCB. The 50Ω input socket should have its tag at 3 o'clock (viewed from the back), while the other tag should be between 7 and 8 o'clock. Bend the tags up by 90° after the nuts are tightened.

Next, solder two short lengths of tinned copper wire to the 50Ω socket and one to the 1MΩ socket (the two connections to the 50Ω socket minimise the series inductance). This done, solder two short lengths of tinned copper wire into the central hollow pins of the connectors.

Remove the counter module from the case and test the fit of the front panel over the switches. Bend the earth links from the BNC sockets to engage the PCB holes, then slide the module and panel together into the case. The leads from the input sockets can now be soldered to the display PCB.

Finally, the wiring between the mains switch and the terminal block can be installed. Be sure to use mains-rated cable for this job, and cover the switch terminals with spaghetti insulation or heatshrink tubing to prevent accidental electric shock. For good measure, we also covered the entire switch body and part of the leads with additional heatshrink tubing.

Don't forget to remove the link installed across the terminal block in place of the mains switch earlier on.

Ventilation

It is important to ventilate the case correctly if you want the best possible frequency stability.

Before drilling the bottom of the case, you will have to remove some of the plastic pillars that are in the way. This is best done with a spot-facing drill (see panel on drill sharpening). This will quickly cut the pillar right down flush with the surrounding plastic.

We drilled four rows of holes in the front left-hand area of the case bottom, and another two rows on the other side of the ribbed section. The ribbed section was left undrilled (see photos pages 39 and 43, November 1987). This allows cool air to flow up under the main counter chip and around the 10MHz crystal.

A small hole must also be drilled in the lid of the case, directly above the 40pF trimmer capacitor. This hole allows external adjustment of the trimmer during calibration. It is located 26mm back from the rear-most PCB guide rail, and 47mm in from the inside edge of the case (note: if the display PCB occupies the third PCB slot, read 29mm instead of 26mm). Drill a small hole first, then ream it out to accept one of those little plastic plugs that

signal through the 4024 binary divider's seven stages. The 7.8125Hz signal (at the output of the sixth stage) will sound like a series of fast clicks.

To check the passage of the 500Hz signals through any of the 4016 analog switches, connect the headphones *across* the switch, using two resistors as probes. It is easy to tell when a particular analog switch is closed — it should be almost silent when its corresponding controlling Range or Function button is pressed.

Faults in the signal path selection logic can be quickly tracked down using DC voltage measurements. The logic levels at the ECL gates are described in the panel on ECL logic but note that some of the DC control inputs have a logic 0 level less than +3.4V which is OK since any voltage between +3.4V and ground will do for a "0" input.

You can use headphones to trace a 50Hz test signal through the ECL preamplifier, Schmitt trigger, and the ÷5 and ÷2 counters (but see note below).

The logic levels throughout the ECL signal path will be +4.3V (high) and +3.4V (low), and the first two differential amplifiers will be biased in between at +3.8V. A special note of caution here: *any external connection to the signal path will make the 100MHz preamplifier oscillate.* This is why we chose to use a LED to monitor the Schmitt trigger output during the setting up procedure.

You can minimise your chances of disturbing the circuitry by using a resistor as a probe for your multimeter. A value of 10kΩ-100kΩ is suitable for 10MΩ digital or FET analog multimeters, however you must cut the "probing" end quite short. Even a centimetre of lead will upset the sensitive wideband circuitry.

If you are using a low-resistance multimeter, switch to a low voltage range and choose a resistor which will provide a convenient "multiplier" for the reading. The resistor acts as a low-pass filter, preventing feedback between the multimeter leads and the ECL circuitry at high frequencies.

cover the screws on 240V wall outlets.

Finally, fit four rubber feet to the bottom of the case. Construction in now complete.

Calibration

Before attempting calibration, you should allow a warm-up time of at least 15 minutes with the lid on. This will give the instrument time to stabilise and will ensure the best possible accuracy.

To properly calibrate the instrument you will need a signal source of known frequency, with a stability better than one part per million. For most of us, this boils down to one of two choices: either local colour TV transmissions or the 10MHz standard transmissions from WWV Colorado or WWH Hawaii.

The latter is preferred by the author because it has the same frequency as the crystal oscillator. All you need is a domestic shortwave receiver and seven metres of hookup wire as an antenna. Wait until evening, when the ionosphere over the Pacific Ocean will reflect a fairly good signal, and position the DFM near the antenna so that its radiated 10MHz clock signal is about the same strength as the incoming signal. Adjust the 40pF trimmer with a plastic screwdriver until you have a zero beat.

If the shortwave receiver has a tuning meter, you can watch the beats when the frequency is too low to be audible. Adjustment to within 1Hz is often possible.

Most colour TV transmissions are synchronised to atomic clock standards and the 4.43361875MHz colour subcarrier oscillator in your TV receiver is phase-locked to these transmissions. The easiest place to gain access to this signal is right at the 4.43MHz crystal. Use a probe made from a 10MΩ resistor shunted by a small capacitor of between 1pF and 3.3pF, depending on the capacitance of the shielded cable you are using.

You can tell whether the subcarrier frequency has been disturbed or not by keeping an eye on the colours in the picture.

The 15.625kHz line scanning frequency is also derived from the same accurate standard and you may be able to pick this up from the stray radiation around the line output stage, without making an actual connection to the TV. Unfortunately, there are less digits to play with in this case so, to obtain the highest accuracy, switch to Period mode and adjust the trimmer for a reading of 64.0000μsec.

If you decide not to calibrate the instrument, just set the 40pF capacitor to about 10% less than full mesh. This places a nominal 20pF across the crystal and the frequency will be within 10 or 20ppm, depending on the crystal tolerance.

Note: some 10MHz crystals will require a nominal shunt capacitance of 30pF. You can easily tell if this is the case because you will not get a zero beat, even with the 40pF trimmer fully meshed. The cure is to add some additional capacitance across the trimmer and the existing 39pF capacitor. A pair of 15pF or 18pF capacitors should be sufficient. These are best soldered to the underside of the PCB with very short leads.

If this still doesn't trim the crystal to the correct frequency, then you may have been supplied with a series-resonant crystal by mistake.

All capacitors used around the crystal oscillator should be high quality types; eg, polystyrene or Philips NPO miniature ceramic plate.

Fig.12 shows the warm-up drift of one of the prototypes which used a cheap 10MHz crystal and an imported power transformer which ran quite hot. Surprisingly, the drift was less than 1ppm. Better quality components will give even better stability.

Your new 1GHz Digital Frequency Meter is now ready for work. We hope that you find it a useful addition to your range of test equipment.

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The Musicolor Mk IV is four chase patterns plus auto chase and reverse chase AND four channel colour organ with built-in microphone means you're ready to start a lightshow! Cat K-3143

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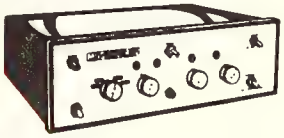

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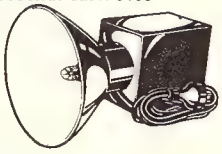

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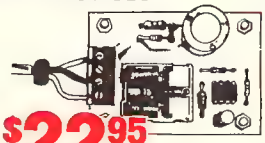

Nothing's worse than a car that misbehaves. Especially if you're trying to knock it off. Imagine, starts, but very soon splutters and stops. Bill Sykes thinks the car's crook and goes off searching for another! You return to your car, reset the ignition killer — and drive away! Cat K-3255

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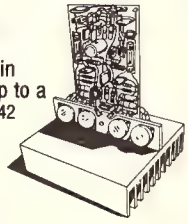

Use two for stereo, or even use in bridge for double output! (Get up to a massive 200W output!) Cat K-3442

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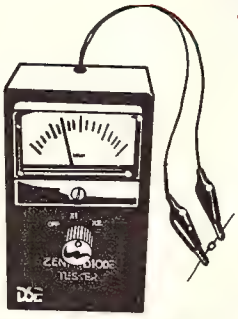

Let's see. Out with the power supply. Work out the series resistor. Get the voltmeter and put it across the zener. Turn on the supply. Woops! Wrong resistor. One cooker Zener... Or you can build the Zener Diode Tester. Very simply and accurately checks Zeners without danger. Especially handy in the service lab when the markings are worn off! Cat K-3051

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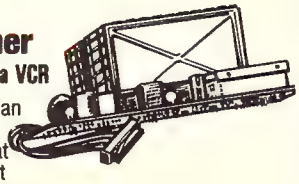

The Teletext Tuner can be built into your Teletext Decoder (Cat K-6315) so you don't need to own a VCR. Kit comes complete with everything you'll need including comprehensive, easy to follow instructions. Cat K-6319

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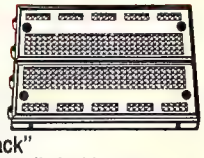
Mini Project Board



80 x 60 x 8mm board with 58 groups of 5 connected terminal points. Grid is laid out in alpha-numeric format for simple "track" identification, and the board is supplied with a pad of overlays so you can mark out circuitry for later use or for transferring to pcb/matrix board. Cat P-4614

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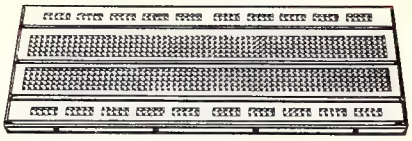
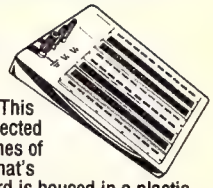


Project Boards PLUS!



A complete mini work bench! This one has 256 groups of 5 connected terminal points plus 16 bus lines of 25 connected terminals. But that's not all: the 130 x 170mm board is housed in a plastic "work bench" complete with three terminals (for power connection, input/output, etc). Overall size is 150 x 225 x 20mm. **Bonus:** Work pad included for circuit working. Cat P-4616

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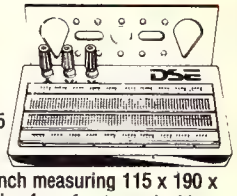
And one with a panel!



128 groups of five terminal points plus 8 bus lines of 25 points in a protoboard measuring 173 x 65 x 8mm. Housed in a plastic work bench measuring 115 x 190 x 15mm, complete with provision for a front panel with holes for pots, switches, even TO-3 transistors! Three terminals are also included for connection. Cat P-4617

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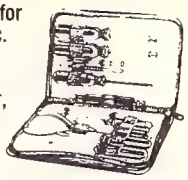

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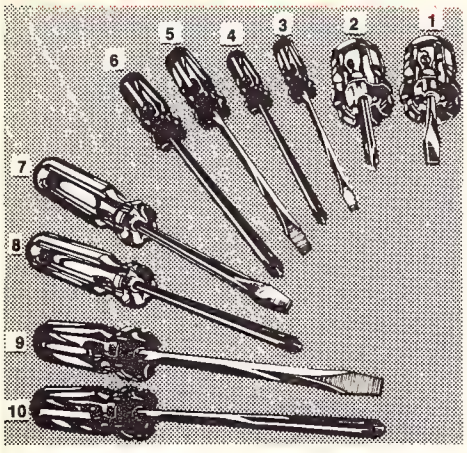

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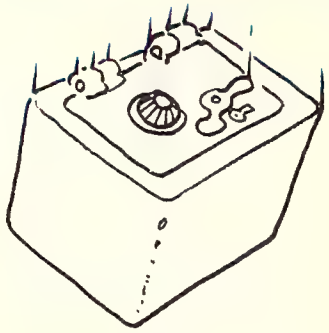
SERVICEMAN'S LOG

When the chips are down

I didn't have much trouble deciding which story to relate this month. It was a case of Murphy at his best. Start at one end of the circuit and it will be at the other end; start in the middle and you'll move towards the wrong end. Either way, you can't win.



LAST KNOWN PICTURE OF MURPHY, ABOUT TO BE HIT BY A FALLING SAFE WHILST DROWNING IN A FLASH FLOOD OF ACID RAIN ON THE NULLABOR PLAIN.....

The story concerns an AWA-Mitsubishi 63cm colour set, model 6346, one of several models based on the ML series chassis. This is a very recent model and, in fact, the particular set was still under warranty, the owner having purchased it three months earlier. He was a new customer, having recently moved into the district, and apparently had been directed to me as the nearest serviceman authorised to provide warranty service for AWA sets.

The first contact was by phone, initially to confirm that I could provide the service and then to find out what was involved. I confirmed that I could provide the service, but explained that it would be his responsibility to bring the set to me. Warranty agreements do not cover house calls, or the cost of transport to or from the service department. The customer accepted this situation philosophically enough: "No problem — I'll borrer me mate's ute."

Those points clarified I made some attempt to determine the nature of the fault; loss of picture, loss of colour, loss of sound or what?

"Aw no — the picture's gone all funny; kind of collapsed, if y'know what I mean."

I wasn't sure whether I did or not. The best guess was frame collapse, although the implication was that there was still some kind of a picture to be seen. Perhaps it was only a partial collapse. There was obviously no point in probing further; I would just have to wait and see.

And so it was that the "mate's ute" eventually turned up with the set on board, and we carried it into the workshop. I took the opportunity to connect an antenna and switch it on, just in case there were any points to clarify while the owner was still there. I suppose I can hardly blame the owner for his "all funny" description. The first 75mm at the top of the screen was blank, the next 100mm showed a reasonably linear picture, from there to within 50mm or so of the bottom was grossly expanded, and the rest of the picture compressed into that last 50mm.

It was, literally, not a pretty picture.

Other commitments prevented me from delving any deeper at that stage and I put the set aside for a day or so. When I did get around to it I fished out the circuit and concentrated on the vertical section (Fig.1).

Special Notice

These notes are being contributed by the author who, from 1950 until July this year, wrote "The Serviceman" in another magazine. We feel sure that regular readers of that series will welcome the opportunity to continue following his adventures in SILICON CHIP.

Jungle IC

In fact, there wasn't a great deal to be seen. Most of the functions were performed inside a 48-pin jungle type chip (IC201, MC1310AP), including the vertical sync separator, vertical oscillator, ramp generator, and an amplifier which delivered a signal at pin 16, which was applied directly to a vertical output pair, Q451 and 452. And that seemed to be all there was to it.

I concentrated on the output stage for a start. I checked the various minor components, including two diodes, D451 and 452, but found nothing suspicious. Similarly, a voltage check around the two transistors produced figures very close to those shown on the circuit.

The next logical step seemed to be to get the CRO going and check appropriate waveforms. The circuit shows two vertical waveforms, one at the vertical oscillator pin of the IC (pin 20, waveform 8), and one at the vertical output pin (pin 16, waveform 7). I checked waveform 8 first, and this came up virtually identical with the photograph on the circuit.

But waveform 7 was another matter. Even the photograph on the circuit suggests that there is some "mush" on the pattern and this appeared to be even more so on my CRO. But this aside, the shape was nothing like that on the circuit, although the amplitude was approximately the same.

So what was happening? Was the chip at fault and delivering a faulty waveform to the output stage, or was the output stage at fault and somehow loading the chip and distorting the waveform. Since I had already checked the output stage fairly thoroughly I hesitated to blame it. On the other hand, as I have remarked before, I am less inclined these days to suspect an IC until all other possibilities have seemingly been exhausted. And there could still be something funny about one or other of those output transistors, which didn't show up on my voltage check.

The transistors are each mounted on a U-shaped aluminium heatsink, the "U" being inverted so that the heatsink sits above the main board. The ends of the vertical sections are cut to provide narrow tongues which fit into slots in the board, then bent slightly to hold them in place. It was necessary to remove the heatsinks from the board in order to gain access to the transistors, but this was not particularly difficult.

Unfortunately, the effort seemed to be wasted. Both transistors tested OK, as did the two diodes, which I tested a second time while the transistors were out of circuit. I also double checked the minor components (resistors and capacitors), and the height and linearity controls, until I finally convinced myself that there was nothing in that part of the circuit which I hadn't cleared.

Which seemed to put suspicion squarely back on the chip. But still I hesitated, trying to think of anything I might have overlooked. I drew a blank and was rapidly reaching the conclusion that the chip would have to be replaced, if only to prove the point one way or the other. After all, I could easily spend several hours searching vainly for some external fault, which may not actually exist, and finally be forced to change the chip anyway.

On the other hand, if I changed the chip now, that point would be settled once and for all. Granted, I'd be down the cost of a chip if I was wrong (but one chip up in my stock) and down by the time needed to change the chip. Now I don't pretend to like changing chips, particularly 48-pin monsters — I don't suppose anybody does — but I've developed a pretty good routine and a fair amount of skill over the years, and can usually do the job in about 15 minutes. That's no record, and I know some blokes who can do it quicker, but it's time well spent to prove a point.

Sydney or the bush

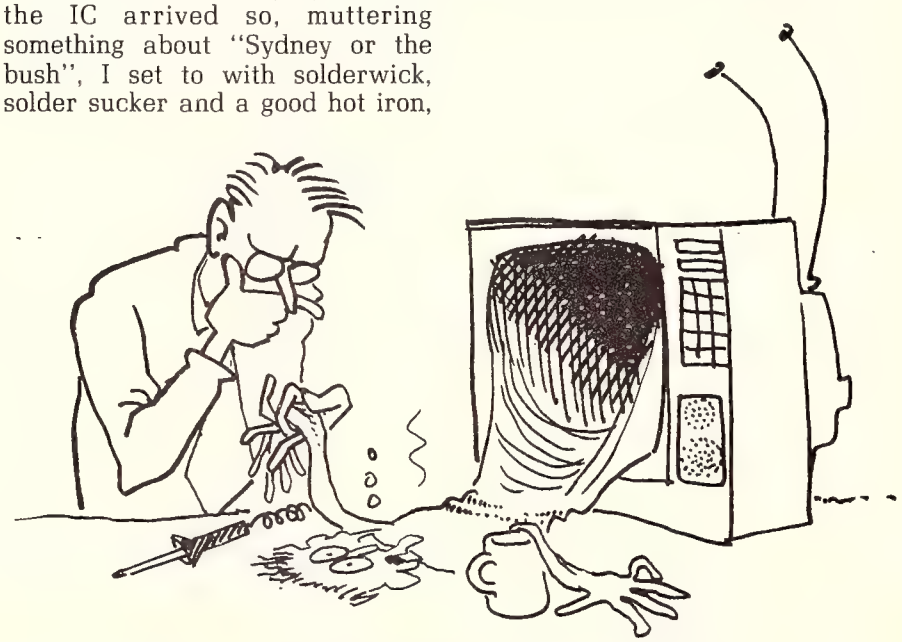
A more practical snag was that I didn't have such a chip in stock, so one had to be ordered, which at least gave me time to think while I was awaiting delivery. In fact, this didn't help much; I had not thought of any other possibility by the time the IC arrived so, muttering something about "Sydney or the bush", I set to with solderwick, solder sucker and a good hot iron, and pulled out the suspect chip.

The whole operation went smoothly enough and I subsequently fitted the new IC, tidied everything up, and switched on hopefully. I don't suppose I need spell it out; it wouldn't have been worth writing about if it had been as easy as all that. Suffice it to say that the set behaved exactly as before. I was back to square one.

So what now? Up to this point I had convinced myself that I had thought of everything before I changed the chip. Quite obviously I hadn't, but I was at a loss to think of some new line of attack. I went over the circuit again. I had proved, the hard way, that the chip was not at fault. I was also convinced that there were no faulty components in the output stage. So what did that leave?

It was more of a growing suspicion than a sudden inspiration but I found myself thinking more and more about the scan coils and any minor associated components. Faults in scan coils are extremely rare, but I have seen the effect of a shorted turn, and it does some weird things to the picture. In any case, there was not much else left to suspect.

Tracing out the circuit from the vertical output stage to the scan coils revealed the existence of several auxiliary components, apart from the scan coils, and I



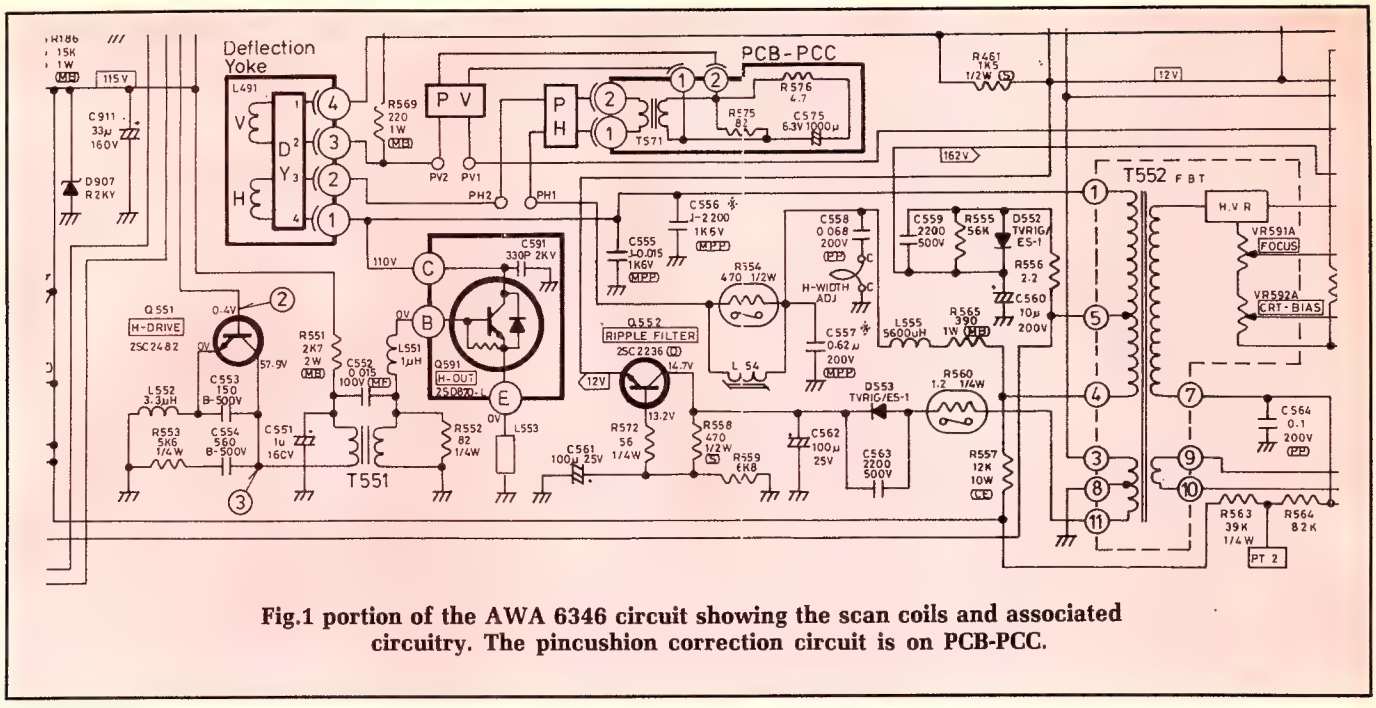


Fig.1 portion of the AWA 6346 circuit showing the scan coils and associated circuitry. The pincushion correction circuit is on PCB-PCC.

made a mental note that these would have to be checked. But first the coils themselves. I fished out a shorted turns tester that I had not had occasion to use for a long time, unplugged the scan coils, and checked for shorted turns. Result: a clean bill of health; there was nothing wrong there.

That left only a few auxiliary components, the main ones being on a small printed circuit board bolted to the side of the cabinet and connected to the scan coil circuit via flying leads and plugs and sockets. The relevant portion of the circuit is reproduced here to assist readers to follow the story. The board is designated PCB-PCC, the "PCC" standing for Pin Cushion Correction. It consists of a transformer, T571, resistors R575 and 576, and capacitor C575.

Connection to the scan coils is via two plug and socket sets; PV (Plug Vertical) and PH (Plug Horizontal). The vertical scan coils are connected to the vertical output stage via pin 4 on the deflection yoke diagram and eventually find their way back to chassis from pin 3, via the pincushion network, and a pair of 8.2Ω resistors in parallel between "PV1" and chassis. These resistors appear to be part of a feedback network, and are not shown here by reason of their remote location.

I had left the set running while I visually checked out this section and related it to the circuit, which meant that the set had been running for about 15 minutes, much longer than I had run it so far, since I had previously turned it on only long enough to check a few voltages or whether the replacement chip had achieved anything. In any case, I had not been observing the circuitry associated with the scan coils.

But now my attention was drawn to R569, a 220Ω, 1W wirewound resistor, mounted on the main board, but effectively connected between pin 3 (vertical scan coil) and the 12V rail. I don't know what function it serves, but I noticed it for the simple reason that it was running stinking hot — literally. So hot, in fact, that it had melted the solder connecting its pigtails to the board.

Well, it seemed that at last I was onto something, even if exactly what was not clear. Looking at the circuit again I suspected that, for some reason, the circuit from pin 3 to chassis was incomplete, forcing the scan current to seek a path through R569 and the 12V rail. And the most likely cause of this would be failure of the two 8.2Ω 0.25W resistors (R462 and 464) already mentioned.

So these were located and checked — only to draw a blank; they were spot on value and completely free from any signs of stress. So much for that theory. But I still had the idea that there was a fault somewhere in this chassis return path and a check with the ohmmeter from pin 3 of the scan coil to chassis confirmed that there was a resistance of several hundred ohms; much higher than seemed logical.

So began a rather laborious process of checking individual connections involving the printed board PCC and the associated plugs, sockets and leads. In detail, PV is a female plug, on a flying lead, which mates with male pins, 1 and 2, on the board. The flying leads are crimped into the plug contacts and I suspected that there could be trouble here. Checking this wasn't easy because of the difficulty of ensuring that one was making an effective connection with the contact inside the plug. But, after several attempts, I finally gave them a tentative all clear.

But what about the board itself, and particularly the pins. The pins are hollow and are mounted by inserting them in a hole in the board, then expanding them with a flaring tool to make a moderately strong mechanical joint. Then, when the board goes through the solder bath, the flared end of the pin is soldered

to the surrounding copper pattern.

I pulled the board out and examined it closely, using a magnifying glass. As far as I could see, all four pins were soldered perfectly to the copper pattern. But the ohmmeter told a different story. Measuring from pin 1 of PCC to the surrounding copper pattern showed virtually zero resistance, but not so pin 2. Here there was a varying resistance of around several hundred ohms.

Significantly, even though I knew there was a fault there, I could not pick it visually. But a few moments work with a hot iron, and a somewhat lavish application of solder and flux, removed any doubt. In fact, I treated all four pins, because I could no longer trust a visual check.

Relief and frustration

Then I switched the set on and up came a perfect picture. I viewed the end result with mixed feelings; relief that I had finally cured the fault, but also a certain amount of anger at the frustration I had experienced, and the time I had wasted, all because of one miserable dry joint. Only someone else who has been through it all will know how I felt.

Still, that's what the game is all about; one has to take the rough with the smooth and, in the ultimate, measure success by the end result. On that basis this job had been a complete success, even if it had been less than satisfactory financially. And I am still puzzled as to how that joint could look so good yet be so poor.

Of course, I had destroyed any evidence in proving the point, and there wasn't much help for that. As I saw the joint, the solder had flowed into the hollow pin and right out to, and over, the edge of the flared end. It had also flowed quite freely over the copper pattern which ran under the flared section, and it looked as though these two runs of solder had mated into one.

Quite obviously they hadn't but, short of using an electron microscope that looks around corners, I am at a loss to suggest how it might have been better checked. The only real answer, I suppose, is if in doubt, resolder it. Which I did of course, but the "doubt" was a long time a-coming.

And now, for a change of pace, here is a story from one of my regular contributors, Mr J.L. of Tasmania. It is an intriguing story involving both technical problems and the ingenuity in solving them, and the frustration caused by the replacement parts problem. This is his story, for which he has nominated the following appropriate title:

TETIA CORNER

Blaupunkt (Bridge Rectifier Chassis)

Symptom: Fuse S1242 blows repeatedly. If the fuse is replaced often enough, the set will eventually fail completely with a clattering noise coming from the chassis.

Cure: D1245 (TAG 3-400) SCR shorted or breaking down under load. An emergency repair can be effected by removing diodes D1242 and D1244 from the bridge board. This reverts the set to its original half-wave rectifier design, in which state it seems to run quite happily.

This information supplied by The Electronics Technicians' Institute of Australia (Tasmanian branch).

Sharp shooting

One thing about television servicing that appeals to me is the uncertainty principle. When a dead set comes into the workshop I never know what killed it, and finding out involves a series of tests and guesses that will, hopefully, point to the faulty part.

This was never more clearly shown than with a Sharp CX2020 that came in recently. Tracking down the fault took both practical and theoretical knowledge, plus experience, suitable test equipment and a pile of patience.

The customer remarked that the set failed to start up when switched on at 7pm, although it had been working perfectly at 5pm. There had been no sparks or smoke, just a total refusal to show any sign of life. He tried the set on a known good power point, just in case, but it was totally dead.

As is the way with so many customers, he felt sure that the picture tube was done for. He wasn't really convinced when I tried to explain that if it was the tube, he should still have sound.

When I switched it on in the workshop, I heard the degaussing coils go "boing" which indicated that part of the set was working. That characteristic degaussing sound meant that the power lead, mains switch and mains fuses were all intact. I could tell this much without even taking the back off.

But that's as far as I could go with the back on. Next it was inside to check the DC power supply. Specifically, there should be about 300V on the collector of the chopper transistor (Q701) and, in this set, 115V on its emitter. The 300V was there, but not the 115V. Quite obviously the chopper was not running.

This set uses a self-oscillating

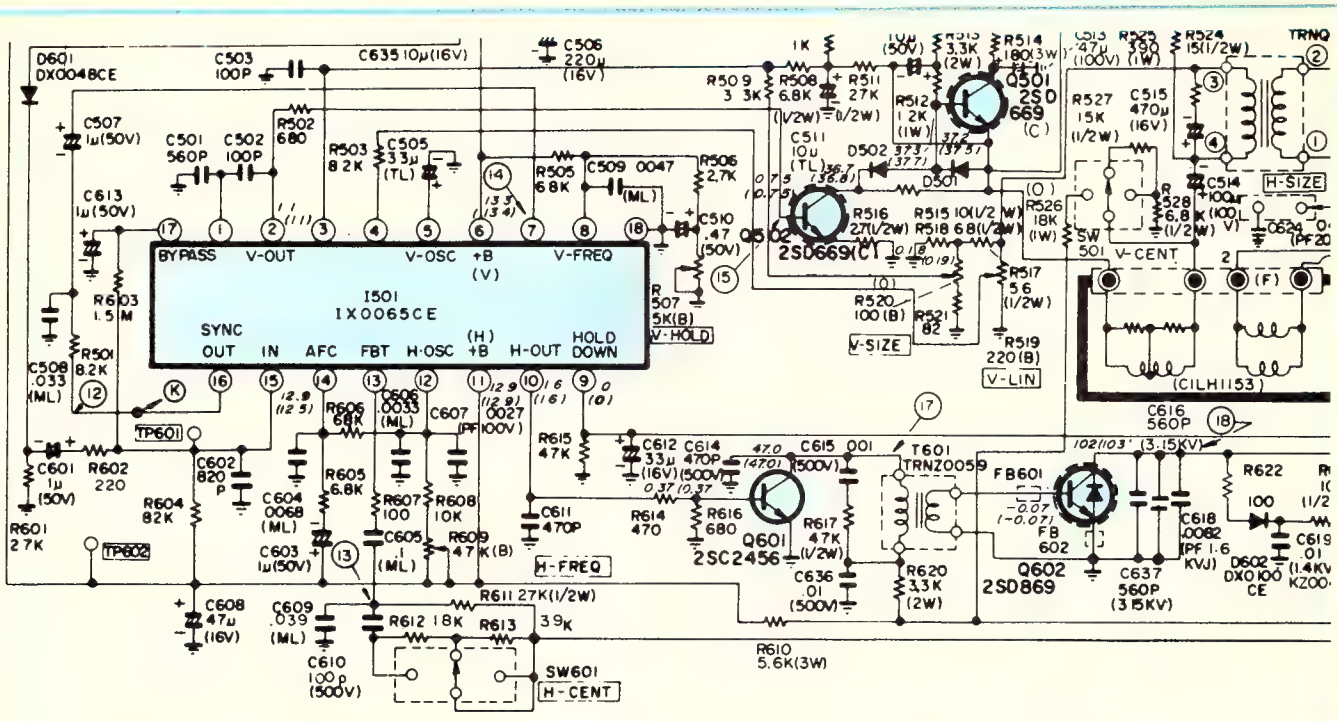


Fig.2: horizontal oscillator (IC501) and line output stage of the Sharp CX2020. Note the protective diode incorporated in Q602.

chopper which should self-start, then come into sync with the line frequency as the line output stage gets going. The pulse from the line stage (Fig.2) is not essential to run the chopper but, as well as its synchronising function, it is used by the protection network to indicate the presence of faults on the line output. No line pulse may mean a fault and so the chopper is shut down.

So where should I start to look for a fault in a roundabout network of this kind.

My first line of attack is to determine if the chopper is trying to self-start. I do this by looking at the emitter of the chopper transistor with the 'scope. If I'm lucky I will see a brief flick of the trace which indicates that the transistor is being turned on, if only for one or two cycles. The output voltage appearing on the emitter is immediately reflected to the protection circuit, and if all is not right, the base drive to the chopper is very promptly terminated.

In this case, the flicker of the scope trace, when it did appear, was so brief as to be almost unnoticeable. Still, it was enough to say that the chopper was trying, and at this point I had to make an educated guess as to where the trouble lay. It could be either a fault in the supply itself, or a fault in the set proper. It's a "heads or tails" situation, but experience helps a little. Line output stage faults are more common than power supply faults.

In fact, faulty line output transistors are so often the cause of stoppages that most servicemen check that component first of all. It's usually simple to reach the collector and measure its resistance to chassis. If the meter shows zero ohms, then the transistor is like the Christmas turkey. In this case there was no such indication and the transistor (Q602) checked out perfectly.

Well, sort of perfectly, because the base-emitter junction is difficult to check in circuit, normally showing as a short through the line drive transformer. Still, if collector-emitter shows no sign of leakage then it's a safe bet that the base emitter junction is OK. Or so one might think.

My next move was to connect the CRO to the base of the line output transistor to see if there was any drive reaching this point. Again, this was inconclusive because the trace merely flickered, without any evidence of a drive waveform. I transferred the probe to the collector of the transistor, hoping to see a similar flicker there. I already knew that the 115V rail appeared briefly, so if the line output transistor was being driven at all, there should be some signs on the collector side. But there wasn't a sausage.

Unusual failure

Up to this point I hadn't switched on the soldering iron, but the time had come and in a couple of minutes I had the 2SD869 line output transistor lying naked on the bench. And now I could really detect the cause of the trouble. The base emitter junction was as short a short as any short I have ever seen. It is an unusual failure for a power transistor because the base-collector junction seemed undamaged, and there was no trace of leakage between collector and emitter.

So now I had the problem of replacing a 2SD869. This transistor is one of those odd animals with a built in protection diode, used in a number of recent vintage Japanese sets. Replacing these can be quite a

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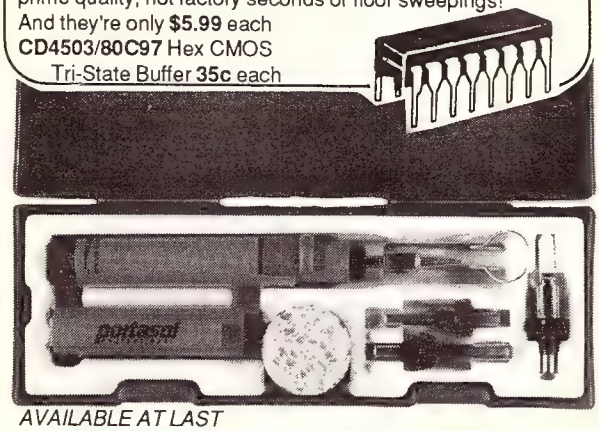

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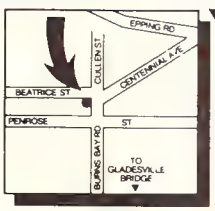

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pain as each manufacturer seems to have his own design and none seem to be compatible.

Here in Tasmania we have a real spare parts problem as all manufacturers have withdrawn their spare parts services to centres in Melbourne or Sydney. So our Tasmanian customers are now faced with 10 to 20 day delays while we order the part, then wait for the invoice, then send the cheque, then finally get the part. (I know — some firms do have faster services, but most do not and our gripe is with the latter ones).

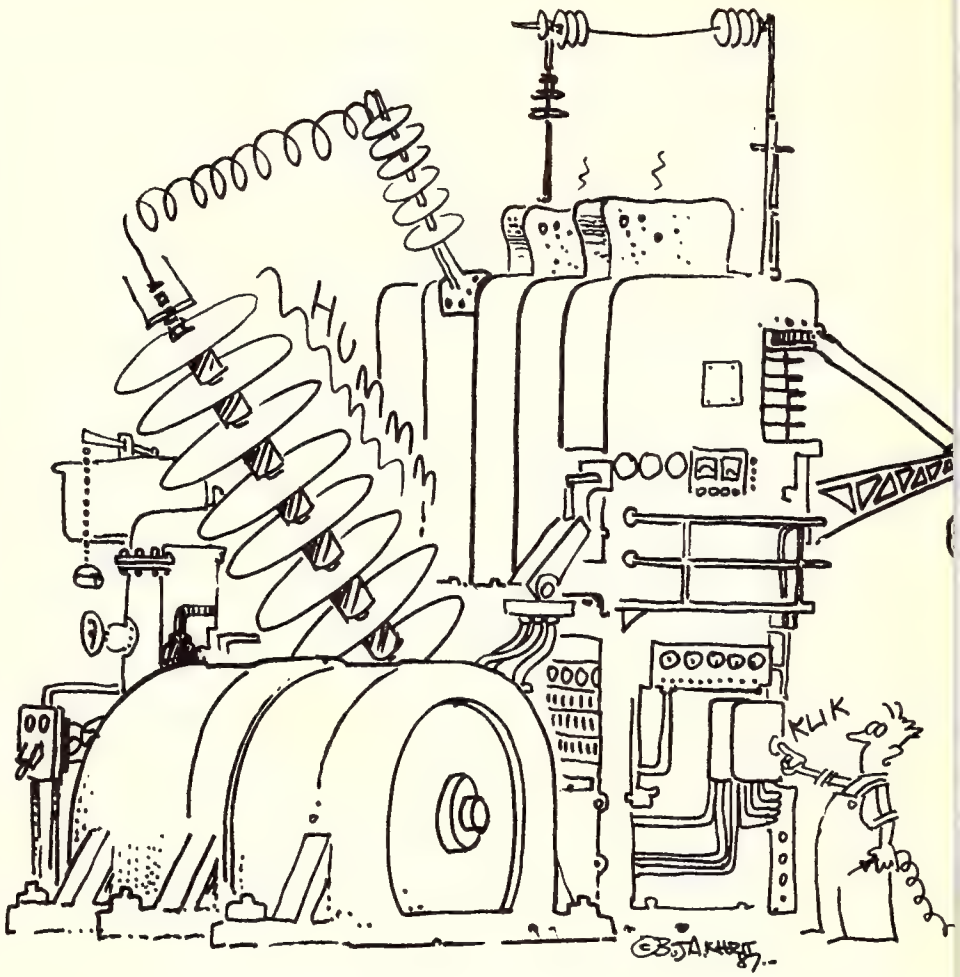
The only alternative for independent servicemen like myself is to cultivate our friendships with the manufacturers' service agents. If they have what I require, and my face is welcome in their workshops, then I might be able to get the parts needed to put my customers' sets back into working order in a reasonable time.

So my immediate need for a 2SD869 led me to the local Sharp agent. When I asked his receptionist about the availability of 2SD869's, a voice from deep within the workshop declaimed "Yer don't need wunna them! A 2SD350 is OK in that set." The voice was soon joined to the jovial face of their technician who volunteered the information that the 2SD869 was only a 1000V transistor, and the diode was included to catch any spikes over that level. On the other hand, a 2SD350 was a 1500V device and to his knowledge, none had ever failed in these sets.

He wouldn't tell me the price of the 2SD869, but as the 2SD350 is about as cheap as any power transistor can be, I decided then and there to use one in this repair. So I soon had a 2SD350 in the chassis, in place of the original transistor.

Pressing the power switch produced not the expected burst of sound, but quite the opposite — absolutely nothing. This was a real disappointment because I was convinced that the transistor had been the only faulty part in the set.

So I had to start troubleshooting all over again. This time the CRO on the chopper base showed a quarter second burst of drive waveform. The 115V rail also showed a change



IT'S RATHER CRUDE, BUT I HAVEN'T HAD THE TIME OR MONEY TO BUILD A BETTER HIGH VOLTAGE POWER SUPPLY....

— the 'scope trace at the emitter leapt up the screen, then quickly dropped back to the zero line. This was a much more positive response than the earlier flicker, but it was no closer to restoring full operation.

Continuing my investigations, I found that the line output transistor now showed more enthusiasm at switch-on, but couldn't be resolved into actual drive. It just flickered into some kind of action, them died. So what now? It could be (a) a faulty line oscillator chip (IC501), (b) a dud line driver transistor (Q601), (c) a bad line driver transformer (T601), etc, etc. With a chain of doubts like this, it is perhaps best to start at the beginning.

My 'scope was not able to resolve any trace of line drive from the oscillator chip at switch on, but then a quarter of a second or less is not very long to resolve anything. What I had to do was power up the chip and see if it produced the right waveform. I used a 9V battery fitted with leads and alligator clips to apply Vcc to the chip. The set uses a 12V rail at this point, but 9V is enough to see if things will work at all. In this case, 9V produced a solid train of square waves and proved the chip to be 100%.

While the battery was connected I was able to trace the signal up to the base of the line driver transistor. They went no further because the collector is powered from the 115V rail and this wasn't working yet. So I had to devise a way to get voltage onto this rail.

One of the most useful pieces of equipment in my workshop is a

Variac, a continuously variable autotransformer. I have also built up a simple DC power supply using an old TV transformer, a couple of diodes and a 350V electrolytic capacitor. When fed from the Variac, this supply can deliver from about 20V up to something over 200V. (It's rather crude, but I haven't had either the time or the money to build a better high voltage power supply).

For this Sharp job, I connected the DC supply to the 115V rail and slowly cranked up the Variac. The 9V battery was still connected, and the IC was delivering drive pulses to the line driver transistor.

The voltmeter monitoring the 115V rail at first indicated a rising voltage, but it stabilised at about 5V and went no higher. Even 100V AC into the DC supply could produce no more than 5V out, and the Variac was humming ominously.

The story is nearly finished!

I took no time at all to find that the 115V rail was shorted almost down to chassis. Examination of the schematic showed two components as the likely culprits. One was C713, a 100μF 160V electrolytic capacitor, and the other was ZD702, a zener diode, type EX0074CE, connected between the rail and chassis.

Roast dinner

The more I thought about that zener the more dubious it looked. Then in the parts list I found that it was a 130V type, twice as high a voltage as any zener I've ever seen. I'd bet a dud fuse to a roast dinner that it was the villain. And so it was. Not quite a dead short, about 10 ohms, but near enough to stop the set dead in its tracks.

The zener is only in the set as a protection device and the set works quite happily without it. But it is there for safety reasons and had to be replaced. So now came the second spare parts trauma with this set — where do you get a 130V zener if not from the set's maker?

Fortunately, the zener value is not critical and I was able to replace the faulty item with two 62V zeners in series. The set is now, if anything, a little safer than it was.

Getting back to the philosophy expressed at the beginning of this story, I find television servicing an occupation that is intellectually stimulating and full of interest. It is never boring and the smile on the face of the customer when he learns that it wasn't the picture tube after all is all the job satisfaction that I could ask for.

Alternative transistors

Thank you J.L. for a most interesting story and an insight into the problems faced by our colleagues in more remote areas.

I have no doubt that there may be those who would question the wisdom of substituting the unprotected 2SD350 in place of the original 2SD869, in spite of the higher rating of the former.

In fact, when I showed this story to a colleague he immediately rattled of a list of protected output transistors, which he felt could at least be considered. These included the 2SD870, 871, 899, 900, 951, 952, 953 and 954. However, neither he nor I would be prepared to stick our necks out and claim that all of these would be compatible with the Sharp circuit.

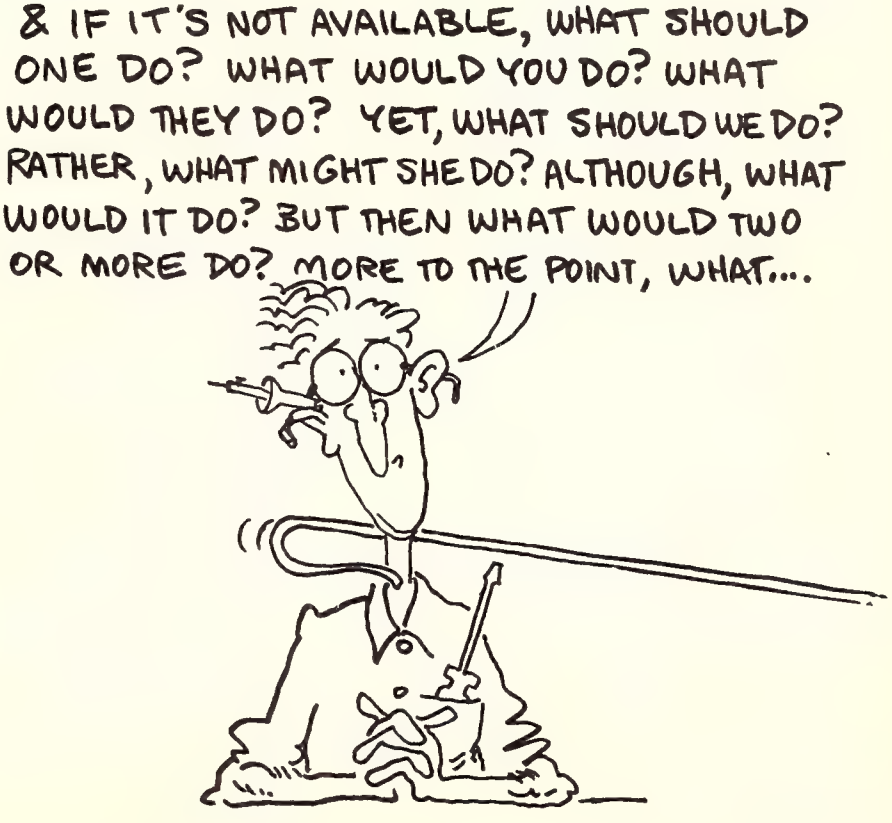
(Incidentally, most transistors of this general type, with built in protection diodes, also have an in-built resistor between base and emitter. This is not always shown on the circuit symbol and could be mistaken for leakage. Typical value is about 40Ω.

More to the point, of course, is the essentially practical problem faced by J.L. and others who live in places remote from the manufacturers' distributors. And even then the expression "on back order" crops up all too frequently.

Obviously, all is not cider and skittles in the Apple Isle, at least as far as spare parts are concerned. This being so, people like J.L. have to do the best they can with what is available. And at least the substitution was recommended by the manufacturer's agent who, in turn, appeared to be basing the recommendation on practical experience.

And I'm sure that no one would have been happier than J.L. had he been able to fit the correct replacement but, if it's not available and a long wait is involved what should one do? What would you do? More to the point, perhaps, what would I do?

See you next month? sc


& IF IT'S NOT AVAILABLE, WHAT SHOULD ONE DO? WHAT WOULD YOU DO? WHAT WOULD THEY DO? YET, WHAT SHOULD WE DO? RATHER, WHAT MIGHT SHE DO? ALTHOUGH, WHAT WOULD IT DO? BUT THEN WHAT WOULD TWO OR MORE DO? MORE TO THE POINT, WHAT...

Listen to hidden FM transmissions

Subcarrier adaptor for FM tuners

This simple adaptor circuit fits in your FM tuner and lets you tap into hidden FM transmissions.

By JOHN CLARKE & LEO SIMPSON

Just recently the Department of Transport & Communications announced that it is ready to authorise subcarrier transmissions on FM broadcasts. Testing of these transmissions is going on right now and you can listen to them by building this simple adaptor circuit.

In America, subcarrier transmissions on FM broadcasts have been used for years. The Americans refer to these services as Subsidiary Communications Authorisation or SCA. It is based on a 67kHz subcarrier which is placed on the main FM carrier.

In Australia the same system is being used but it will be known as Supplementary Monophonic Transmission (SMT) which will be generally recognised as an Ancillary Communications Service (ACS). Not a very inspiring name, is it?

Australian tests have been on single sub-carrier transmissions at 67kHz but developments in the USA provide for multiple sub-carriers, some carrying digital data and others carrying audio.

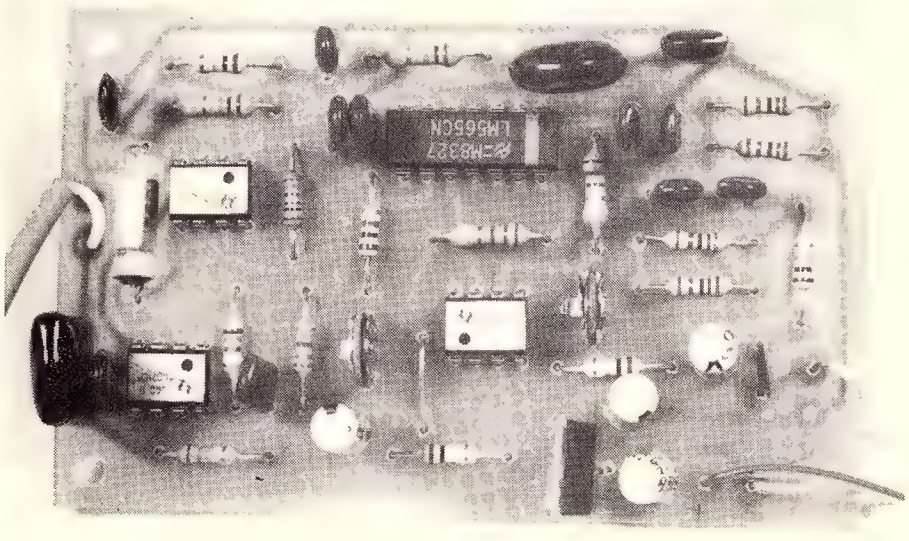
Now 67kHz sub-carrier transmissions are about to be authorised as regular services in Australia. To coincide with this, we have designed a suitable adaptor which can be hooked into most FM tuners with a minimum of fuss. Low in cost, it uses just a few readily available integrated circuits.

Before we describe the circuit of the adaptor, let's briefly talk about FM subcarrier transmissions. They will have no effect on standard FM mono and stereo radios. Also, they will be fully compatible with all existing FM radios, whether stereo or mono. In fact, unbeknown to the great mass of FM listeners, test transmissions have been going on for some time.

But while all FM radios are presently unaffected they are able to pick up the sub-carrier transmissions and, with the addition of an adaptor such as the one we describe here, able to detect the audio signals which will generally be music.

While we were developing this adaptor circuit, the ABC in Sydney was running ACS test transmissions on 2ABC-FM. The audio modulation was the program simultaneously being broadcast by AM station 2BL. In the near future, ACS broadcasts are likely to be background music suitable for offices and factories.

SILICON CHIP'S ACS Adaptor is built on a compact printed circuit board (PCB) accommodating three low cost op amps — a phase lock loop IC, a 3-terminal regulator and a handful of resistors and capacitors.



This the ACS adaptor board, shown about 30% larger than actual size. All the parts are readily available.

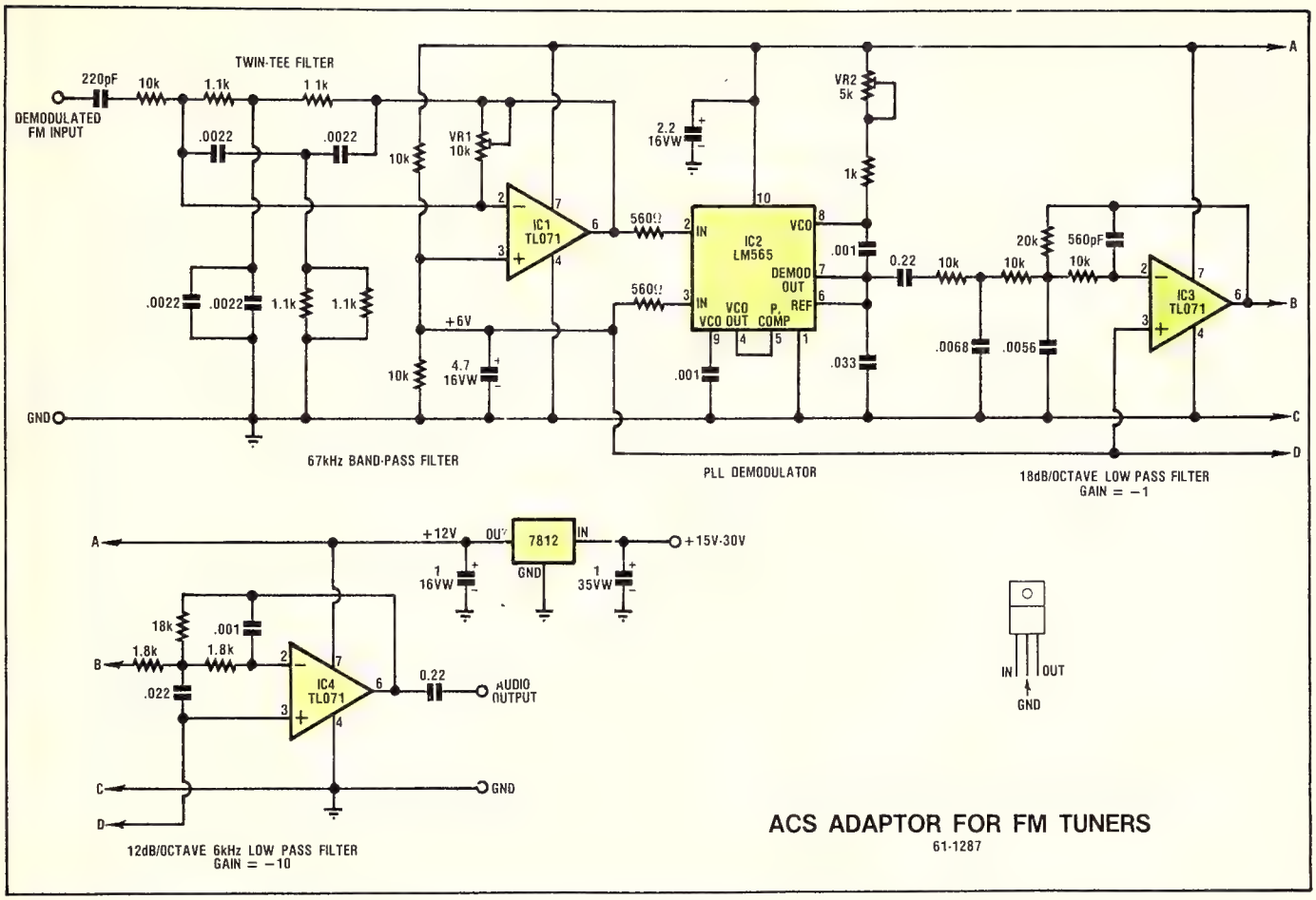


Fig.2: the circuit for the ACS adaptor is essentially just a phase lock loop with input and output filtering stages. Note that TL081 op amps may be substituted for the TL071s.

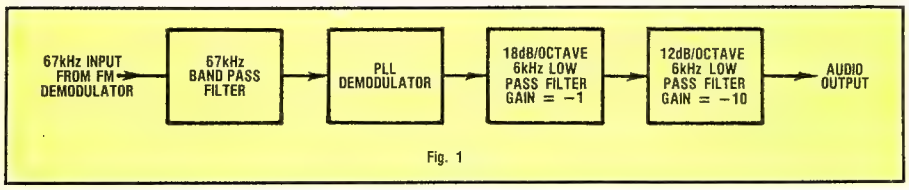

67kHz INPUT FROM FM DEMODULATOR
67kHz BAND PASS FILTER
PLL DEMODULATOR
18dB/OCTAVE 6kHz LOW PASS FILTER GAIN = −1
12dB/OCTAVE 6kHz LOW PASS FILTER GAIN = −10
AUDIO OUTPUT
Fig. 1

Fig.1: this block diagram shows the four circuit functions of the ACS Adaptor. The corresponding functions are also marked on the circuit diagram (Fig.2).

How it works

Fig.1 shows a block diagram of our circuit. The 67kHz signal present at the output of the FM detector (in the radio to be modified) is first fed to a 67kHz bandpass filter and then to a phase-lock loop (PLL) which recovers the audio modulation on the 67kHz sub-carrier.

The audio output of the PLL is then passed through a low pass filter which attenuates frequencies above 6kHz at the rate of 18dB/octave. Another 12dB/octave low-pass filter stage completes the conditioning of the signal before it is passed to an external audio amplifier.

Fig.2 shows the complete circuit. Op amp IC1 and associated components provide the 67kHz bandpass filter. A twin-T network comprising four 1.1kΩ resistors and associated 0.0022μF capacitors is connected in the feedback network of the op amp. This gives some gain at 67kHz and heavy attenuation for frequencies above and below this frequency.

An additional passive filter at the input to the twin-T network (220pF and 10kΩ) provides some additional rolloff for frequencies below 67kHz.

In practice, the bandpass action covers a frequency range of about 10kHz above and below the 67kHz centre frequency. VR1 sets the gain of the bandpass filter stage.

IC2 is a Signetics NE565 phase-lock loop which demodulates the 67kHz frequency modulated (FM) signal from IC1. The NE565 PLL consists of a voltage controlled oscillator (VCO) set to 67kHz and a comparator which compares the incoming frequency modulated 67kHz signal at pin 2 with the VCO signal fed into pin 5.

The output of the comparator represents the phase difference between the incoming signal and the VCO signal and is therefore the audio modulation of the subcarrier. Treble de-emphasis (150μs) is provided by a 0.033μF capacitor (pin 7).

The free-running VCO frequency is determined by the 0.001μF capacitor at pin 9 and the resistance between the positive rail and pin 8 (1kΩ in series with VR2). VR2 adjusts the oscillator frequency (also known as the "centre frequency") so that the incoming

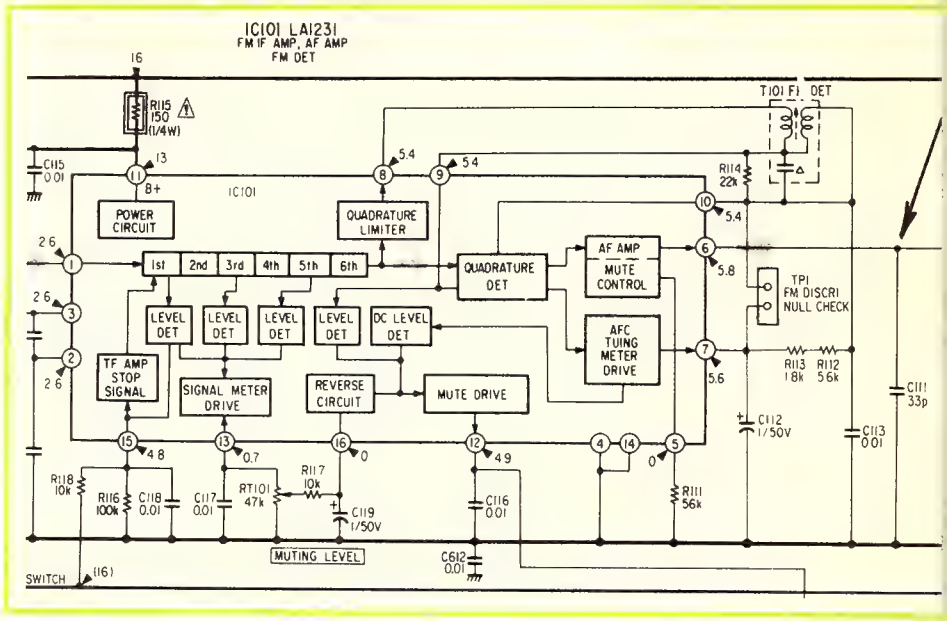
signal is within the lock range of the PLL.

To minimise noise in the demodulated output, it is important to reduce the lock range of the PLL to a minimum. This is achieved by shorting pins 6 and 7 together. To a lesser extent, the lock range and therefore the noise output becomes smaller for lower input signals so we keep the input signal reasonably low without prejudicing the PLL's operation.

Following IC2 is the 18dB/octave filter employing IC3 which has a gain of one for wanted signal frequencies. This filter is followed by the final filter stage IC4 which has a gain of ten.

The adaptor is ideally powered from the tuner or receiver it is built into so we had to make its input voltage requirements non-critical. The solution is to use a 12V 3-terminal regulator which enables the circuit to be powered from any unregulated DC rail from +15 to +30 volts.

The three op amp ICs and the PLL



This photo shows the ACS adaptor installed in an older AM/FM stereo receiver, the Harman Kardon hk570i. We used two brackets to suspend the Adaptor above the tuner board of the receiver.

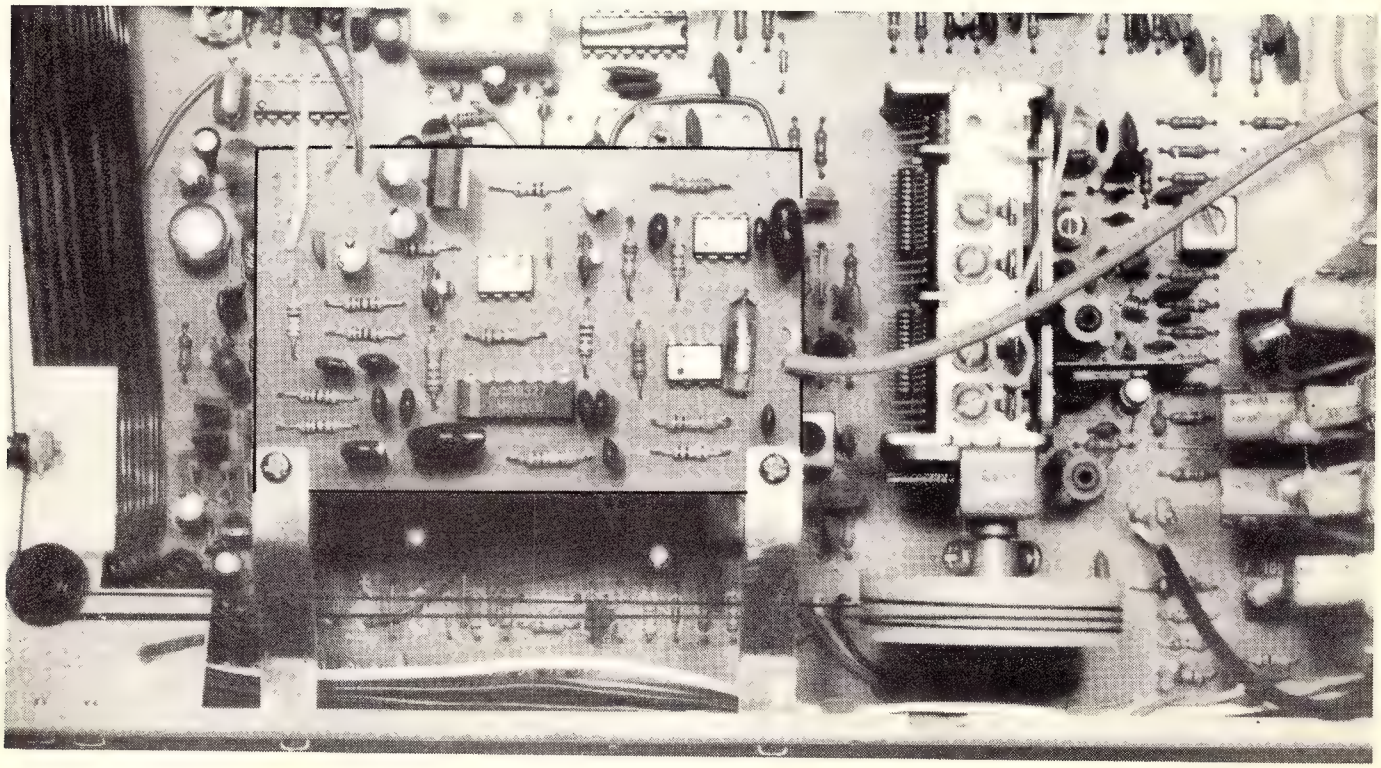
are all biased to half the supply voltage by a voltage divider consisting of two 10kΩ resistors which is decoupled by a 4.7μF capacitor. The centre-point of this voltage divider is connected to pin 3 of each op amp and the PLL.

PCB assembly

The PCB for this project measures just 57 x 89mm and is easily assembled.

No special points need to be watched when installing the parts on the PCB except that component polarities must be correct. Note also that IC1 has a different orientation to IC2, 3 and 4.

When assembly and soldering are finished, check your work carefully and then connect a DC supply of between 15 and 30 volts. Now check the voltage at the output of the 3-terminal regulator, at pin 7 of the TL071 op amps, and at pin 10 of the PLL. In each case the reading should be close to 12V. The voltage at pin 3 of each IC should be close



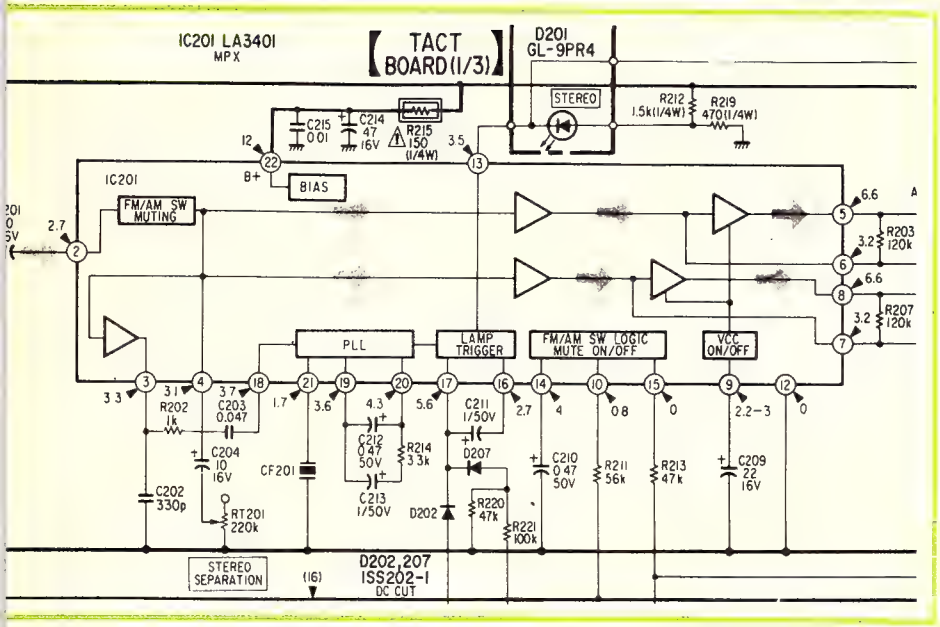


Fig.3: this is a portion of a typical FM/AM tuner (Sony ST-JX220A) showing where the ACS adaptor is tapped in, across C111, between the FM detector and the multiplex decoder.

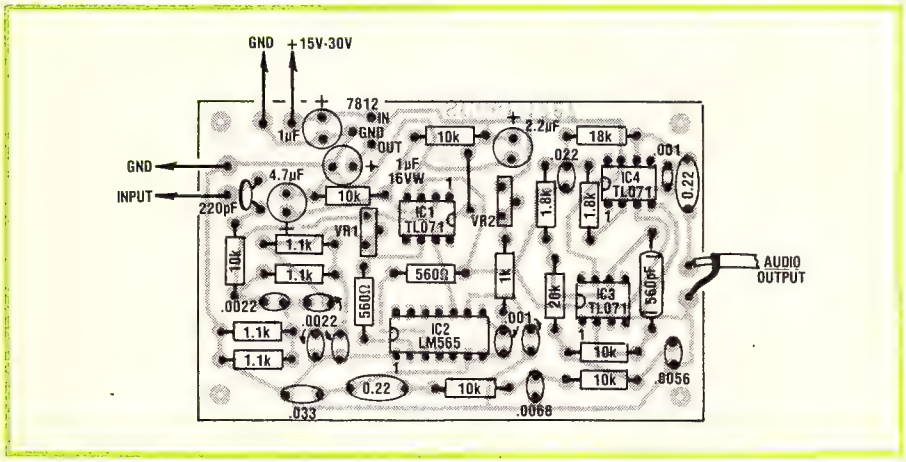


Fig.4: take care when assembling the board. Note that IC1 is oriented differently from IC3 and IC4.

to 6V and so should the voltage at pin 6 of each TL071.

If everything is okey dokey, you are ready to install the adaptor in your FM tuner or stereo receiver.

Finding the signal

This is the tricky part. Ideally, you need access to the circuit diagram of your tuner or receiver. You need to identify a positive DC supply rail of between +15 and +30 volts. Then you need to find the output of the FM demodulator.

In a stereo tuner this comes before the multiplex decoder and treble de-emphasis networks. In a mono tuner, you must identify the demodulator output before de-emphasis. After de-emphasis, the 67kHz signal will be non-existent.

We have shown part of a typical FM tuner circuit (Sony ST-JX220A) as an example of where the 67kHz signal must be picked off. As with most medium priced tuners, it uses two ICs to do most of its FM processing. These are the IF amp and detector IC and the following multiplex (MPX) decoder IC. The most convenient point to pick off the 67kHz signal is at the input to the MPX decoder.

Setting up

Having found the signal and made the necessary connections from the adaptor to your tuner, the

continued on page 95

PARTS LIST

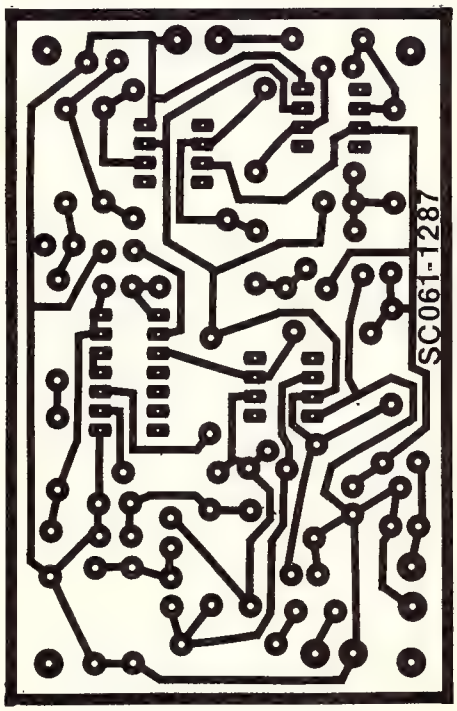
1 PCB, code SC061-1287, 57 x 89mm
3 TL071, LF351 FET input op amps
1 NE565 phase lock loop
1 7812 3-terminal 12V regulator

Capacitors

1 4.7µF 16VW PC electrolytic
1 2.2µF 16VW PC electrolytic
1 1µF 35VW PC electrolytic
1 1µF 16VW PC electrolytic
2 0.22µF metallised polyester
1 .033µF metallised polyester
1 .022µF metallised polyester
1 .0068µF metallised polyester
1 .0056µF metallised polyester
4 .0022µF metallised polyester
3 .001µF metallised polyester
1 560pF polystyrene
1 220pF ceramic

Resistors (0.25W, 5%)
1 x 20kΩ 2%, 1 x 18kΩ, 6 x 10kΩ, 2 x 1.8kΩ, 4 x 1.1kΩ 2%, 1 x 1kΩ, 2 x 560Ω, 1 x 10kΩ miniature vertical trimpot, 1 x 5kΩ miniature vertical trimpot

Miscellaneous
Hookup wire, audio leads, solder etc.



Full size PC artwork for the ACS Adaptor. Design by John Clarke. Luvverly, innit?

Ship-to-shore dialling for all boat owners

OTC'S AUTOMATIC SEAPHONE SERVICE

Boating enthusiasts on the waterways and coasts of Australia can now have direct dialling to any phone number in Australia or anywhere in the world with OTC's new automatic VHF Seaphone service.

By LEO SIMPSON

Most people will be familiar with Telecom's new cellular phone service which is becoming very popular with business people who spend much of their day in their cars and trucks. Now OTC's automatic Seaphone service is doing for boats what the cellullar phone service has done for cars but at much lower cost.

OTC's VHF Seaphone service has been operating since 1976 and has been gradually expanding over the years to the point where even relatively minor coastal population centres now have it.

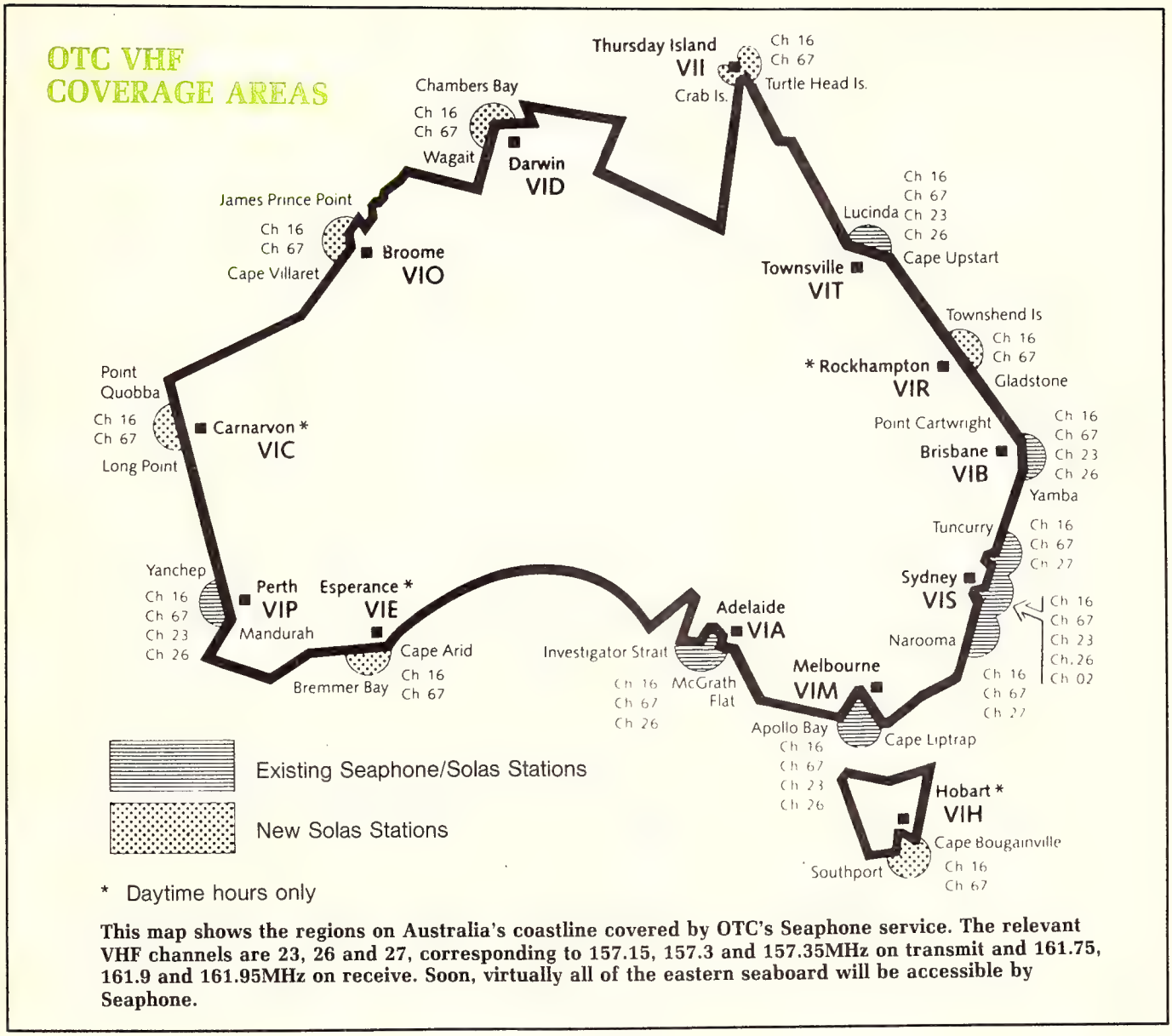
Early this year though, OTC decided to substantially upgrade the service so that people on the waterways and as far away as 100km out to sea could have direct phone dialling, ship-to-shore. Local electronics company Heyden-Spike Ltd won the tender to develop the system and has now produced a computerised system which will radically alter communications on the water.

The problem of automation

OTC (standing for Australia's Overseas Telecommunications Commission) could foresee a large obstacle in introducing an automated Seaphone service: cost to the boat-owners. OTC recognised that if the new Seaphone service was to be really popular the cost of upgrading to it for each boat-owner would have to be low.

That meant that all existing VHF marine radios would have to be usable and the cost of any fancy dialling facility would also have to be lower than the cost of a new radio. This meant that the new equipment on the boat would have to be kept relatively simple while all the "intelligence" would have to be installed at OTC radio bases on shore. And that is what has happened.

Heyden-Spike Ltd has developed a microphone which, in addition, to the usual press-to-talk switch, has 12 pushbuttons for phone dialling. The microphone can be fitted to any existing VHF marine radio although it cannot be simply plugged in. The radio must first be modified to sup-



This map shows the regions on Australia's coastline covered by OTC's Seaphone service. The relevant VHF channels are 23, 26 and 27, corresponding to 157.15, 157.3 and 157.35MHz on transmit and 161.75, 161.9 and 161.95MHz on receive. Soon, virtually all of the eastern seaboard will be accessible by Seaphone.

ply 12 volts to the microphone circuitry.

Inside the microphone housing are two printed circuit boards, one for the keyboard and the other for the 44-pin dedicated Motorola microprocessor which has its own inbuilt memory (RAM and EPROM). The processor provides the DTMF (dual tone multi frequency) tones for dialling and the code which identifies every Seaphone licence holder.

Each Seaphone licence holder will be allocated a subscriber number but, for security, the code stored in the microphone electronics will be known only to the OTC computers.

Note that all the existing OTC Seaphone services will be available to marine radio users but the new automatic service will only be usable with those radios which have been modified with the new microphone.

Features of the service

The automatic Seaphone service will be used as follows. The user switches the VHF marine radio to a free channel (eg Ch 02, 23, 26 or 27) and listens to ensure that no calls are in progress. The phone number can then be dialled, preceded by the STD number for Australian calls or by the country code for international calls.

The user then presses the "*" button to transmit the stored user's auto-Seaphone identifier to OTC's computerised radio base station. The user's code number is then validated by the computer which checks to see that the code is valid and that bills have been paid. A brief voice announcement will then state that "your call is being connected". Normal ring tone will be heard and when the called party answers, call charges are recorded by the computer.

While the call is in progress, the user operates the press-to-talk button in the normal way. When the call is finished, the customer presses the "#" button to reset the system.

If a call can't be connected, a voice announcement tells the user

Mr Kerry Stratton demonstrates the new push-button microphone which is the upgrade for VHF marine radios using OTC's direct-dial Seaphone service. Heyden-Spike Ltd (Brookvale, NSW) developed the new service and the microphone.

that message and if the code is not valid or recent accounts have not been paid, the user is connected to a (human) operator at the radio base to sort out the problem.

Naturally, calls can be made from shore to ship but they have to be made via the OTC base radio. This means that a telephone user calls base radio and asks to contact a person on the water. Whether or not the call makes immediate contact depends on whether the marine radio is turned on and tuned to the calling channel, and is within range.

On the existing Seaphone service this situation is taken care of by the message system. Callers leave messages with the base radio and when the boat-owner calls in, the base radio operator can place calls. As can be imagined, this process can be quite time consuming, both for the radio operator and boat owner.

In the new automatic Seaphone service, the boat owner merely presses the "*" button on the microphone at any time to interrogate the OTC system for "any Seaphone calls on hand". An automated voice announcement will respond to the call and if there are messages, the system will automatically connect and bill the Seaphone call to the shore telephone subscriber who booked the call earlier. That's a nifty arrangement which must have taken a lot of thought to develop.

Dial 999 for emergency

In a distress situation, it is normal practice to use Channel 16 with voice contact to the base radio or a nearby vessel. With the automated Seaphone service though there is a quicker way to draw attention to an emergency situation. By dialling 999 on any OTC Seaphone channel, an immediate alarm will be activated and the computerised system will automatically display the vessel's name, call sign, type and the owner's name and address on the screen at radio base.

The emergency 999 function will override any Seaphone call in progress on the selected channel.

Cost of the new service

The new service is not expensive, particularly as far as the initial set-up costs are concerned. The cost of the new microphone plus fitting to a marine radio is $249. Phone charges are $1.30 per minute. At the time of writing OTC was considering the introduction of a 6-second normal tariff charge.

On the face of it, this new automatic Seaphone service from OTC must be a winner. It is convenient, easy to use, and reasonably priced.

Mailbag — continued from page 3

there are *two faults*, a broken earth and a defective neutral. The problem is that there is no indication of either of these faults until *both of them* occur.

I know a plumber who carries a set of automotive jumper leads and he uses them to bridge the gap when breaking a run of pipe. With MEN, any green-wire fault currents should return to neutral if the water pipe is broken, with no significant voltage being developed above earth. It wouldn't be a problem and hence plumbers would not be aware of it unless there was a faulty neutral, so perhaps faulty neutrals are not uncommon in the system. Maybe plumbers detect them more often than the County Council people.

A. Lackey
Collaroy Plateau, NSW

Extra earth lead

Thanks very much for your article on electrical safety (November 1987). All my life I have been concerned about electrical safety, not so much for myself but for others, particularly those nearest and dearest to me. You should write some more on the subject.

I too am super-cautious. Thirty years ago I fitted an additional earth from our washing machine to the cold water pipe.

You have my support and best wishes.

N. Walker
Como, NSW

An excellent magazine

Yours is an excellent magazine. I had almost given up buying electronics magazines but I will take a subscription to yours. I hope the standard of your first issue is reflected in the future. Being a mechanic by trade and a hobbyist only in electronics, I find your articles well written and understandable.

A. Glover
Cootamundra, NSW

Build this shortwave antenna

Try this antenna switching arrangement and improve your shortwave reception.

By ED NOLL

If you've ever had difficulty in capturing those frequencies on the fringe of the shortwave spectrum, you probably know what a blessing it would be to have more than one antenna at your disposal. Now you can — well not really, but the Flexo SWL Aerial can make it seem as if you do.

The Flexo SWL Aerial is an antenna/antenna-switching system that improves reception by adding flexibility to a single antenna installation, making it seem as if you have more than one antenna. Flexo's extended performance better accommodates the extraordinary frequency span occupied by the many shortwave broadcast bands. In effect, you have more than one choice in dealing with the variables of antenna length, line length, angle-of-signal arrival, and propagation conditions.

With the Flexo, sensitivity is made more uniform over the entire shortwave spectrum. It provides more than one choice in finding an optimum signal-to-noise (S/N) or signal-to-interference ratio when attempting to pull in a specific station. If you listen only to strong signals, the Flexo won't do much for your receiver's performance because of the high-sensitivity, high selectivity, and automatic-gain characteristics of the latest receivers. However, if difficult receiving conditions and weak-signal identification are your bag, give it a try.

When a signal is weak, despite the high sensitivity of the receiver, even a couple of dB of extra input signal may help you obtain an ID. Even the strong signals are subject to brief fades, so a more solid lock is attractive to the music-loving enthusiast. Since the needs of shortwave listeners tend to vary, we'll describe both a simple two-wire Flexo and a really different three-wire version.

The two-wire Flexo

A complete Flexo antenna and switching arrangement is given in Fig.1. Basically, as shown in Fig.1a, the antenna is cut as a dipole on the 60-metre band. A coaxial transmission line feeds the signal to the Flexo switch and another short piece of coax (not shown) then feeds the switch output to the receiver. Note that one antenna wire is angled by 45 degrees in the horizontal plane from the more usual straight line position.

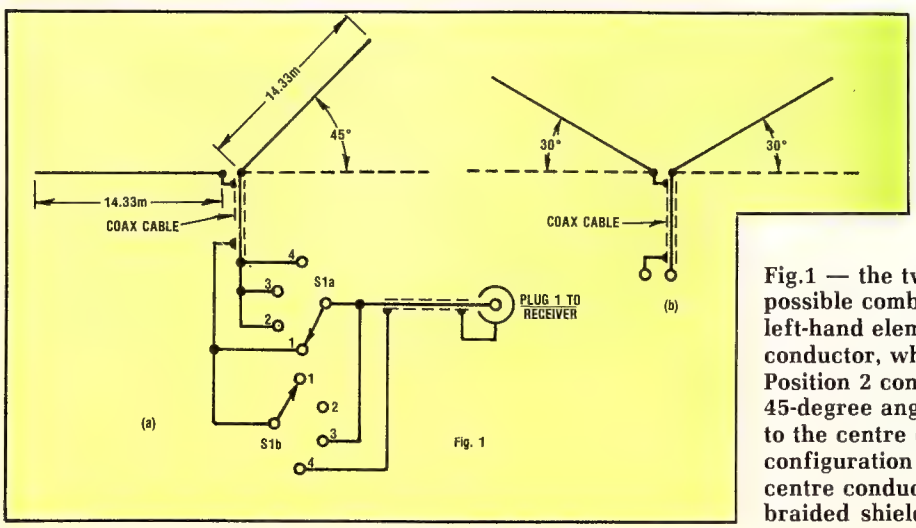


Fig.1 — the two-wire Flexo SWL Aerial gives you four possible combinations. When S1 selects position 1, the left-hand element is connected directly to the centre conductor, which feeds the signal to the receiver. Position 2 connects the element that's offset at a 45-degree angle. In position 3, both elements connect to the centre conductor. Position 4 gives a dipole configuration with one element connected to the centre conductor and the other connected to the braided shield.

PARTS LIST FOR THE FLEXO SWL AERIAL

J1 — Insulated phono jack
S1 — 2-pole, 4 or 6-position switch (see text)
Antenna elements — bare copper wire, AWG #16 or #14
Antenna mast — PVC pipe (see text)
Down lead — coax cable or insulated wire (see text)
Metal box, guys, nuts, bolts, etc.

As shown in Fig.1b, the two antenna elements can be angled also by as much as 30 degrees in the horizontal plane from their usual positions. Thus, they can be positioned to accommodate the mounting space in your back yard.

In tests, it has been found that more reception flexibility is obtained with one element angled rather than straight. The antenna performs pretty much as a dipole on the 41 to 60-metre bands. On the remaining higher-frequency bands, other switch settings were often preferable to the dipole connection. Remember that the antenna wires become longer in terms of wavelength at the higher frequencies and, therefore, often perform more like a long wire.

The antenna mast was made of telescoped sections of PVC piping (as shown in the photos). The coaxial transmission line is fed to the top of the PVC mast by cutting a hole in the mast at about chest-height. Fig.1 shows how the inner conductor and conducting braid (outer conductor) of the coaxial line are connected at the top of the mast. Two bolts serve as the antenna terminals. It is to those terminals that the antenna wires were attached using solder rings. The elements were then stretched out in an inverted-V fashion and brought down to two metal fence posts at ground level. In effect, you are constructing a 60-metre inverted dipole, but one with the antenna wires not necessarily in line.

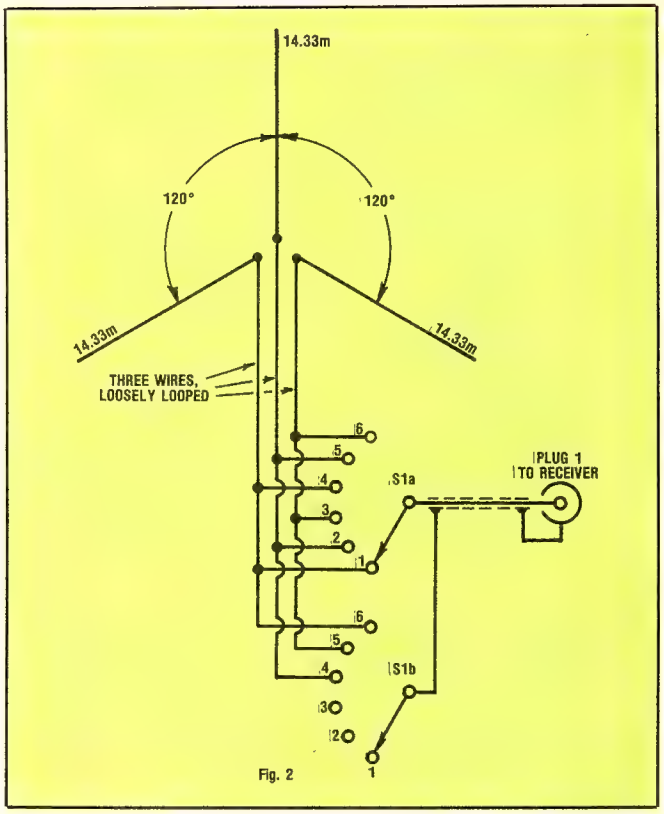
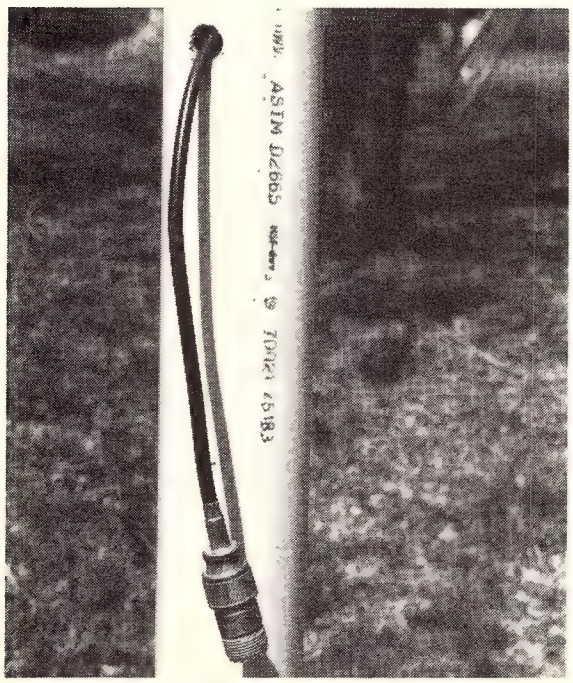
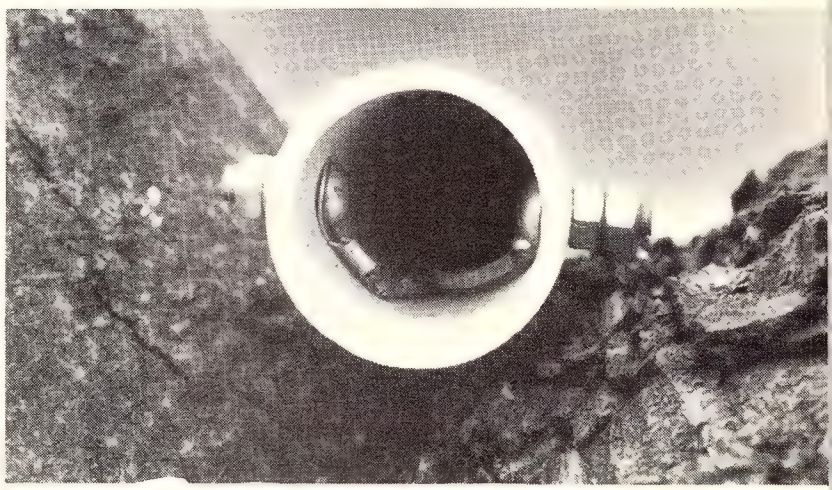


Fig.2 — The three-element Flexo installation provides greater flexibility over the two wire type by allowing six combinations.

There are four possible ways to use the two conductors at the receiver end of the coaxial transmission line. You can use the two separate conductors individually (an either-or arrangement), or connected in parallel. The fourth arrangement is to





The coax cable is fed through a hole, drilled about chest-high in the PVC piping, to the top of the mast.

This view of the top of the PVC piping shows that the coax cable terminates in large crimp-on lugs, which are then secured to the mast using nuts and bolts. The antenna wires are then connected to the bolts.

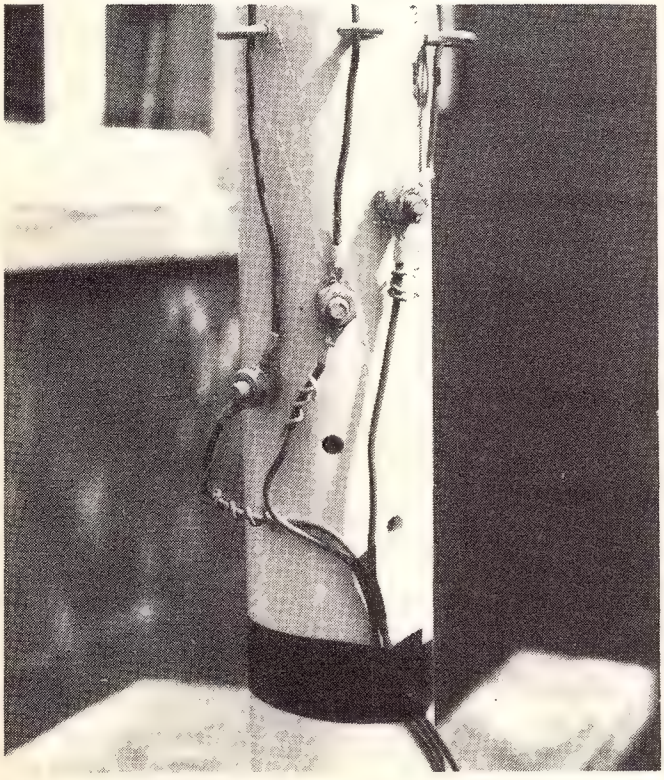
use them in dipole fashion.

The four possible choices are made available by a four-position, two-pole switch. The two switch sections are shown as S1a and S1b in Fig.1a. In switch position 1, the braid of the coaxial line from the antenna is connected to the inner conductor of the short section of coax line that runs to the receiver input. In effect, the coaxial braid and one of the 14.3-metre antenna wires are being used as a single-wire feed antenna. Notice that the braid does not connect to the centre conductor of the coax line.

On position 2 of the switch, the centre conductor of the coax line and its associated antenna element serve as a single-wire antenna. In position 3, the braid and the centre conductor of the coaxial feed line coming from the antenna are connected to the inner conductor of the short section coax line that channels the input signal to the receiver. Thus, both antenna wires are connected to the receiver in a single-wire feed arrangement.

On position 4, the centre conductor and braid of the antenna coax are respectively connected to the centre conductor and braid of the receiver coax. Thus, when position 4 is selected, the antenna operates as a true dipole.

In putting the Flexo switching arrangement together, you must make certain that the braid of the transmission line from the antenna is not connected directly to ground in the switching box. The only time that the braid is connected to ground is when S1 is in position 4. In the author's switching arrangement, the switch was built into a small metal box measuring 80 x 55 x 100mm. On the rear of the box, the author mounted two isolated terminals (as shown in the photos) to which the coaxial line from the antenna is

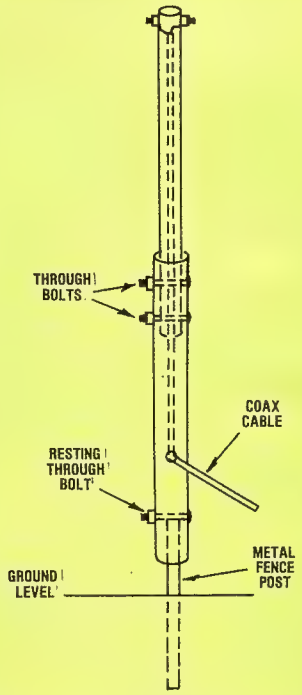


In the three-element installation, the down leads are run down the outside of the PVC piping through screw-eyes, and are connected to the feed-in by bolts installed through the mast.

PVC MAST CONSTRUCTION

An antenna mast can be easily built from telescoping setions of PVC tubing and a few nuts and screws to hold the structure together. A 1.5-metre metal fence post, embedded in the ground, is used as a foundation for the mast. Two 3-metre sections of PVC tubing can be used to construct a mast about 5.4-metres high.

Begin with a 5cm diameter section of PVC tubing and insert a second 3.8cm diameter section of tubing, to a depth of 60cm, into one end. Drill holes through the overlapping sections of tubing and bolt them together. Insert and connect the signal carrying cables as needed. Connect the wires that will



act as the RF (radio frequency) pick-up elements. If guys are to be used, connect them now. Use nylon stranded rope — the smallest diameter you can buy. Drop the mast over the fence post and secure with bolts. Finally, secure the guys. Taller masts can be built by using longer or additional lengths of PVC tubing.

If a taller mast is desired, simply add to the length by joining two 5cm diameter sections of PVC tubing, using a 1-metre length of 3.8cm tubing as a joint support. Insert the joint support about 60cm into the lower section of the mast. Drill holes and bolt the two sections together. Secure the upper section in the same manner, with the two outer lengths of tubing forming as tight a joint as possible. Finish up by adding the RF pick-up elements, signal-carrying cables, etc. as needed.

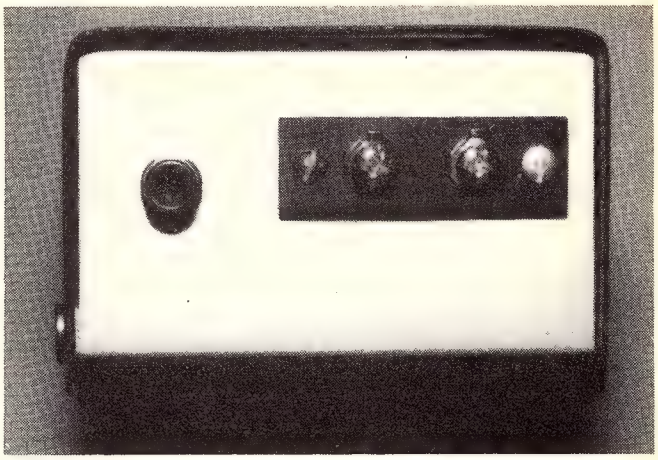
connected. To the left of these is a shielded phono jack to which the coaxial line feeding the receiver is connected. If you have trouble finding a two-pole, four position rotary switch, a two-pole, six-position switch may be substituted.

The three-wire Flexo

Another Flexo aerial uses three antenna wires and a three-conductor transmission line as shown in Fig.2. In that arrangement, the three antenna wires are spaced 120 degrees in the horizontal plane. It, too, is erected in the inverted-V fashion. The ends are dropped down to three metal fence posts near ground level. A view of that configuration is shown in one of the photos. The three transmission line wires run down the outside of the PVC mast through screw eyes to three terminals that are mounted in the PVC piping at chest level. From there, a three-wire transmission line enters the radio room and connects to the Flexo switcher.

When there are three wires that are part of the transmission line, there are as many as twelve individual combinations that can be switched in. However, the six combinations provided by the arrangement shown in Fig.2 give good results, and little improvement can be obtained with additional combinations. The switching arrangement shown can select any individual wire for use as a long-wire antenna. The remaining three positions use the antenna wires in three separate dipole configurations. As a result, the Flexo has some limited directivity when operating as a switched dipole configuration on the lower-frequency bands.

On the higher-frequency bands, the single-wire combinations also display directivity. However, the main advantage is that it gives you six combinations to choose from in obtaining the best reception possible for difficult propagation and interference conditions. Don't expect it to be a cure-all; some additional options may be necessary under difficult conditions.



The switch box is simply an inexpensive metal cabinet that carries the selector switch, two screw terminals and a phono jack.

The switch is a two-pole, six-position type as recommended previously. Note that S1a selects one of the individual antenna wires when in positions 1, 2 and 3. Those same positions on S1b are left unconnected. Thus, you are operating with a single-wire feed for the first three positions and true coaxial feed for the latter three positions. The last three positions (4, 5 and 6) of switch S1b connect the wires in pairs to give a dipole configuration. In the 4, 5 and 6 positions, an appropriate antenna wire is connected to the braid of the small section of coaxial line that connects the output of the switcher to the receiver.

In checking out your results, it may be advantageous to wire the switcher in terms of the physical positioning of each antenna wire. In wiring the Flexo switch, be certain to mount three insulated terminals on the box for connecting the wires from the antenna. You can use the same size box as for the previous antenna. SC

Evolution of Electric Railways: ctd from p.7

of the train line pipe, commonly known as "pulling the train's tail".

By 1950 the railway world was changing fast. Diesel electric locomotives had been increasing in numbers since the war years and superseding many steam locos. The first advantages claimed for the diesels were quicker starting and longer times between overhauls.

As for running cost measured in dollars per ton-mile of train hauled, on some American railroads the diesel electric could do no better than existing steam locomotives. In many countries, including Australia, running costs of old worn-out steam plant serviced in ancient loco sheds did exceed the expense of servicing and refuelling new diesel electric machines in brand-spanking new service shops.

A few United States railroads did show clearly that a large modern steam locomotive could be serviced and refuelled in a well-equipped running shop at a cost less than or equal to the equivalent expense for diesel electric units of the same power. The Norfolk & Western Railway was one such line which built its last steamer in 1953 and continued to use steam locomotives economically right up to April 4th, 1960.

Even then, economy was not the reason for the death of steam. The problem was that they were just about the only railroad left using steam and new parts and plant became virtually unobtainable.

It is interesting that the major manufacturers Alco, Baldwin and Lima in America built their last steam locomotive in 1947, 1949 and 1949 respectively, while in Australia the last steam locomotive to enter service, in January 1957, was a 269 tonne giant, the articulated Garratt built by Beyer, Peacock & Co Ltd, of Manchester England.

So ended the amazing 160 year steam era, with the diesel-electric locomotive now ruling the world's lines. But let us not forget the other contender, the electric locomotive which is widely used around the world, expecially in Europe.

Next month when we will delve into Australia's part in this fascinating saga. SC

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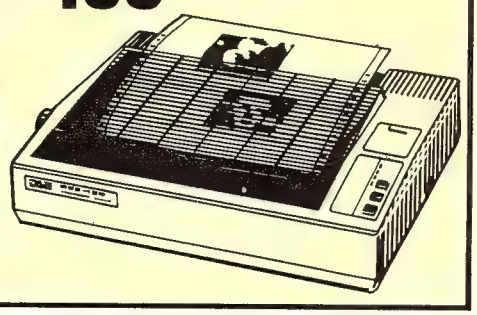

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AMATEUR RADIO

By GARRY CRATT, VK2YBX

Amateur television: getting started

This month, we take a brief look at amateur television and the equipment needed to get started. As well, there's a handy list of amateur TV repeaters and ATV groups.

One of the most technically challenging aspects of amateur radio is the transmission and reception of television signals, on the amateur bands. Old timers and newcomers alike find this medium most satisfying, as most of the equipment used is "home brewed", and program material is mostly of a technical nature.

There are many types of amateur television, ranging from "slow scan" TV (SSTV) which utilises a channel width of only 3kHz, and sequential scanning at an audio rate, to "fast scan" TV (FSTV) which utilises a channel width of 7MHz and transmits 25 pictures per second. As SSTV allows a greater concentration of energy in a smaller portion of the spectrum, the distances over which communications can be achieved are much greater than when using FSTV. Nevertheless, distances exceeding 400km have been achieved using fast scan TV.

Reception

It comes as no surprise to discover that the majority of ATV (amateur TV) activity occurs on the UHF bands, primarily due to the overlap between commercial UHF television and the 570MHz ATV band. This greatly simplifies the equipment required for reception. In fact many operators use a standard band 4 UHF TV antenna and a UHF television receiver for ATV reception.

Naturally a dedicated antenna for UHF channel 35, low loss feedline, and a GasFet preamp will provide superior performance, but it can be seen that very little outlay is required to receive ATV.

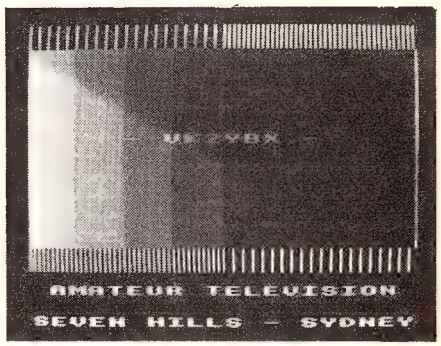


Fig.2: test patterns similar to this one from VK2YBX are often used during ATV test transmissions.

Just as an enormous number of repeaters serve the VHF and UHF FM nets, so too do a number of ATV repeaters. In fact most activity in capital cities is via the local ATV repeater (see Table 1).

As can be seen from the repeater listing, the majority have their output on UHF channel 35 (575-582MHz), so that once a suitable antenna has been obtained, it is simply a matter of determining the location of the nearest repeater, tuning your UHF television to channel 35, and waiting for a signal to appear.

Many ATV repeaters are sponsored and maintained by the relevant state branch of the Wireless Institute of Australia (WIA). The WIA transmits a weekly 30-minute news broadcast, normally on Sunday mornings. These broadcasts are ideal for tuning receivers and adjusting antennae.

Transmission

As with commercial television broadcasts, the vision transmission

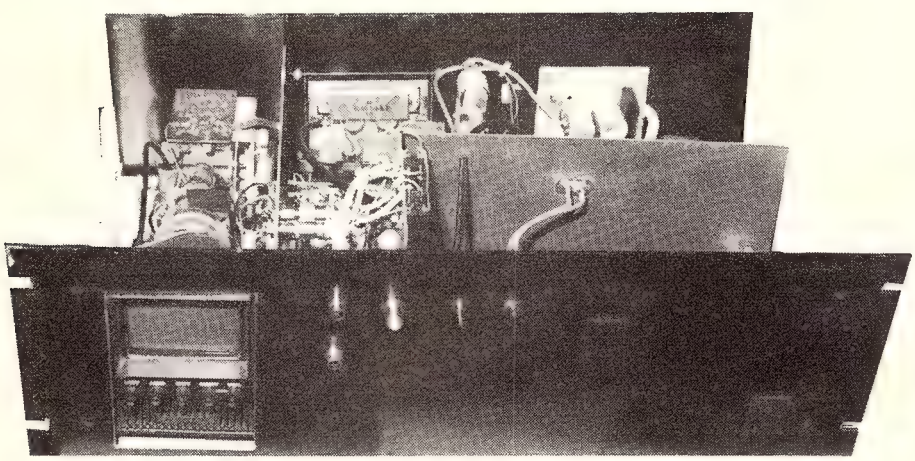


Fig.1: some amateurs prefer to build rather than buy equipment. This photo shows a typical home-made amateur TV station.

Table 1: ATV Repeaters in Australia

Location	Callsign	Vision I/P	Sound I/P	Vision O/P	SoundO/P
Canberra	VK1RTV	426.25	431.75	579.25	584.75
Wagga Wagga	VK2RTW	444.25	449.75	579.25	584.75
Sydney	VK2RTV	426.25	431.75	579.25	584.75
Springwood	VK2RTS	444.25	449.75	579.25	584.75
Newcastle	VK2RTN	426.25	431.75	579.25	584.75
Central Coast	VK2RTG	426.25	431.75	579.25	584.75
Bendigo	VK3RMZ	426.25	431.75	579.25	584.75
Melbourne	VK3RTV	444.25	449.75	579.25	584.75
Brisbane	VK4RAT	444.25	449.75	579.25	584.75
Brisbane	VK4RTV	426.25	431.75	579.25	584.75
Central North	VK5RCN	426.25	431.75	579.25	584.75
Central North	VK5RCN	579.25	584.75	444.25	449.75
Adelaide	VK5RTV	426.25	431.75	579.25	584.75
Adelaide	VK5RTV	444.25	449.75	579.25	584.75
Hockham	VK5RWH	444.25	449.75	1246.25	1251.75
Perth	VK6ROD	426.25	431.75	579.25	584.75
Perth	VK6RUF	426.25	431.75	579.25	584.75
Devonport	VK7RAE	444.25	449.75	579.25	584.75
North West	VK7RTV	444.25	449.75	426.25	431.75

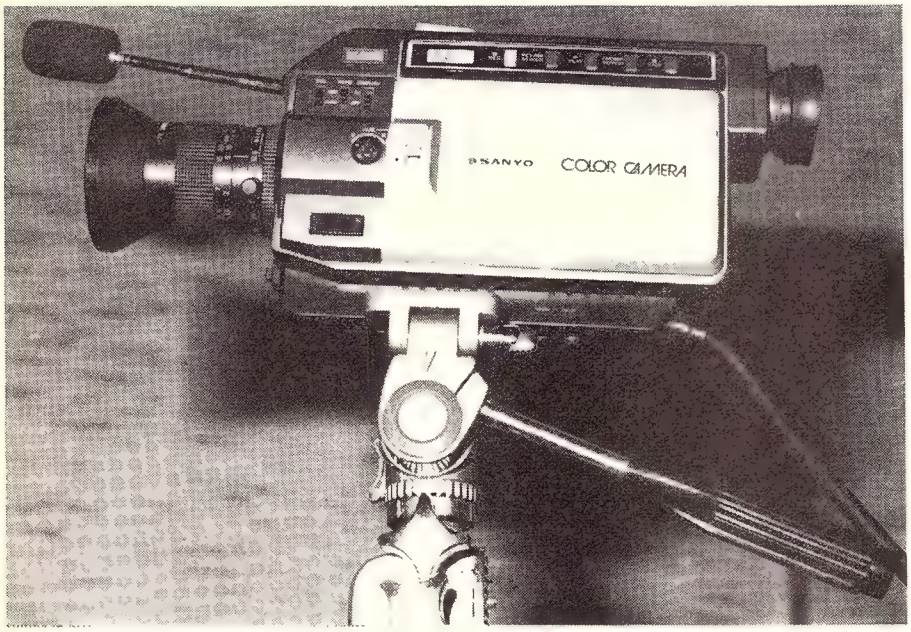


Fig.3: a portable colour or b/w camera is suitable for amateur TV. The composite video output from the camera is fed directly to the transmitter.

is amplitude modulated (AM), whilst the sound is FM. Normally the sound transmitter runs about one tenth the output power of the vision transmitter, where two separate transmitters are used. However, some operators mix the FM sound at the vision transmitter output stage and consequently run even less audio power to minimise intermodulation products.

The standard spacing of 5.5MHz between vision and sound carriers is used to maintain compatibility with domestic receivers. The channel bandwidth is 7MHz.

Wide channel spacing is required if good linearity and adequate video bandwidth is to be obtained. With a standard AM transmission of 625 lines (25 frames per second) with two sidebands and a sound carrier, the channel spacing approaches 12MHz.

This sort of channel width would severely limit the number of available television channels, so a system for reducing the required channel width was developed for commercial TV stations, which is also used by ATV operators.

The Vestigial Sideband (VSB) system, also sometimes known as Asymmetric Sideband (ASB) system, involves filtering out the majority of the upper sideband of the vision signal, reducing the channel width to around 5MHz. By careful compensation in the receiver, the video distortion that would normally result from the removal of most of one sideband can be reduced to negligible proportions.

Sound transmission is FM, and although the techniques are similar to those used for NBFM, the deviation is much greater (50kHz).

Because of the exclusive nature of ATV and the resultant lower level of activity, there are few commercial suppliers of suitable ATV equipment. The South Australian ATV Group, part of the SA branch of the WIA, has a number of

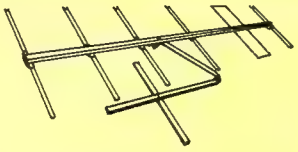


Fig.4: superior results can be obtained by using a resonant antenna. This 580MHz Yagi gives 8dB of gain and is available from Dick Smith Electronics.

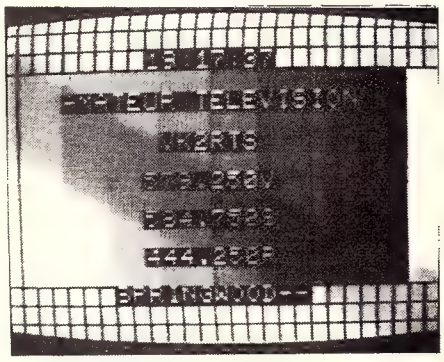


Fig.5: this is the test pattern from VK2RTS at Springwood in NSW.

Fig.6: 1W amateur TV transceiver from PC Electronics, USA.

Table 2: Active ATV Groups

- *Gladesville Amateur Radio Club TV Group* (PO Box 48, Gladesville, 2111, NSW). This club conducts test transmissions on UHF channel 35 on Wednesday evenings 7.30pm-10.30pm, Friday evenings 7.00pm-10.00pm, and Saturday and Sunday evenings at various times. The viewing audience extends from 100km south of Sydney to the northern suburbs. The VK2RTV transmitter runs 20W output into a 9dB omnidirectional antenna. Contact Keith VK2ZZO for further information.
- *Sydney ATV Group* (SATV Group, PO Box 84, Hazlewood, 2779, NSW). This group operates repeater VK2RTS (output UHF CH35). Operation by touch tone. Liason net operates on 147.3MHz simplex every Tuesday evening. VK2RTS re-transmits material from the VK2RTV test transmissions on Saturday at 7.30pm.
- *South East Queensland ATV Group* (SEATV Group, PO Box 3, Chermside, 4032, Qld). VK4RTV repeater input is via valid television signal. 70cm liason frequency is 438.025MHz. 2-metre liason frequency is 147.3MHz. Repeater receive antenna can be rotated by touch tone operation.
- *Wireless Institute of Australia*. Most divisions have an active ATV group. Many state divisions stock ATV publications. See your local phone book under WIA.
- *South Australian ATV Group* (GPO Box 1234, Adelaide, SA 5001). The VK5RTV repeater has been licensed for 12 years. The present repeater is a 20W microprocessor-controlled unit located at O'Halloran Hill, south of Adelaide. Access is via a valid TV signal. The repeater has over 250 touch tone control commands, and is one of the most versatile in Australia. Regular transmissions are made on Wednesday evenings 8pm to 10.30pm, and Sunday mornings from 9am to 10.30am.

  A "sister" repeater to VK5RTV, VK5RCN, is located at Clare, and is powered solely by batteries, charged by a wind generator. This repeater can be cross linked with VK5RTV to provide enhanced ATV coverage form Adelaide to Whyalla and other outlying areas.
- *Victorian Division WIA — ATV Group* (3/105 Hawthorn Rd, Caulfield North, Vic. 3161). VK3RTV operates from Mt. Dandenong and runs 10W into a directional antenna aimed at Geelong and Melbourne. Repeater input is via a video modulated carrier. Touch tone operation is required to activate a colour bar test pattern, and several pages of repeater information. The repeater is solid state and microprocessor controlled, and has a unique "received signal report" function.

transmitter, preamplifier, and receiver kits available, and it is known that the Victorian division of the WIA also had kits available some time ago.

One supplier in the USA, PC Electronics (2522 Paxson Lane, Arcadia, California 91006) regularly advertises a 70cm ATV transceiver, Model TC70-1, which has met with good success in Australia. This company also has a downconverter suitable for the 420-450MHz ATV simplex (and repeater input) band which contains an inbuilt GasFet preamp, Model TVC-4G.

One of the higher bands which is presently being used for FM ATV experimentation, both here and in Europe, is the 23cm band (1240-1300MHz). There are a number of suitable "building blocks" which make ATV reception relatively simple in this band. These include satellite TV downconverters which convert the 950-1250MHz and 950-1750MHz bands to 70MHz. Wyman Research (PO Box 95, Waldron, Indiana 46182) in the USA caters for this type of ATV equipment.

Recommended reading:

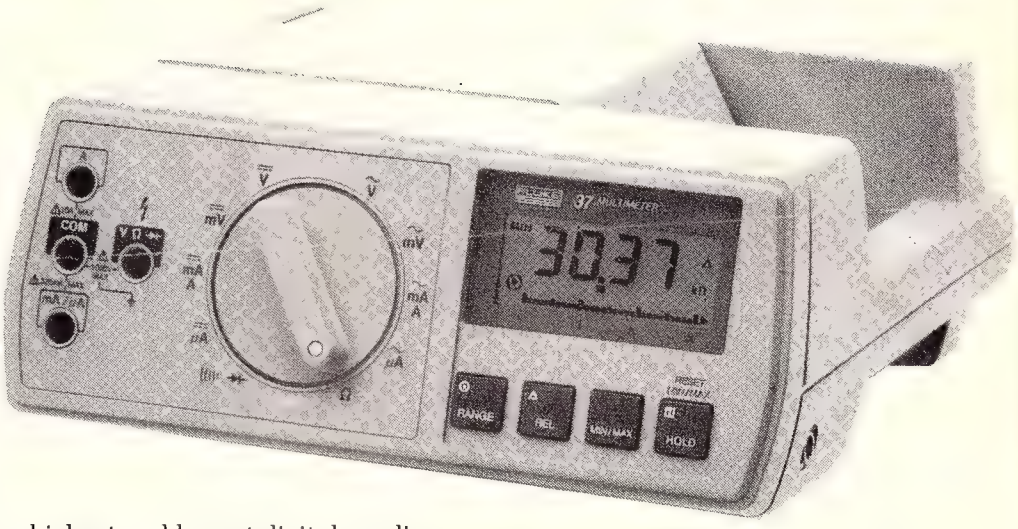
(1). *UHF/VHF Manual*; G.R. Jessop (available from most amateur radio stockists).

(2). *The 1987 ARRL Handbook*; published by the ARRL.

(3.) *Radio and Television Broadcast Stations 1986*; Australian Government Publishing Service.

PRODUCT SHOWCASE

Bench/portable multimeter from Fluke



Most technicians and enthusiasts will already be familiar with the popular Fluke 70-series digital multimeters and their rugged-20 series for use in areas where dirt and grime is problem. Complementing that range is the Fluke 37 bench/portable DMM which offers additional facilities to the former meters.

As with the 70 and 20-series, the Fluke 37 is auto-ranging, has 3200 count offering greater resolution than standard multimeters, and it has the bargraph feature which is handy for nulling and peaking since it responds faster than the digital display.

Naturally, it can be used with all standard Fluke probes and accessories.

The 37 model offers min/max recording whereby it will store the highest and lowest digital readings, over long intervals, as much as several days. This can be very handy in servicing and design work. It also offers Relative Mode, which shows the change between a stored reading and any following reading. This can also be useful for nulling test lead resistance.

All these features are incorporated in an attractive bench style case which has a tilting foot and a built-in compartment for test lead and accessory storage. The model 37 is priced at $490 plus 20% sales tax where applicable.

Enquiries should be directed to Obiat Pty Ltd, PO Box 37, Beaconsfield, NSW. Phone (02) 698 4776.

Cute pedal accessories from Cutec

Arista has a range of eight audio accessories for guitarists. All are housed in a sturdy plastic box with heavy pedal operated switch and powered by a 9V battery (Eveready 216 or equivalent). No power switch is fitted as this function is performed when a jack is placed into the input socket.

We had a look at three of the units in the range and can confirm that they are ruggedly built, well finished and quite suited to being stomped on with a size 12 boot.

Typical of the range is the Stereo Chorus which uses bucket brigade devices to produce the time delay necessary to simulate two voices. The Over Drive is a distortion circuit giving a similar effect to an over-driven amplifier fuzz box

while the Stereo Phaser is a dynamic phase shifter which gives effects from tremolo to a jet sound.

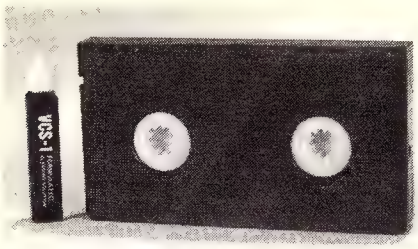
Other units in the Cutec range are a Flanger, Stereo Analog Delay (for echo and reverb effects), Graphic Equaliser and Parametric Equaliser. All units have simulated stereo outputs by the way.

The Cutec range is marketed by Arista and is widely available from hifi dealers and electronic parts suppliers.

Wet-dry head cleaner for VCRs

While there is a certain amount of controversy over head cleaning tapes just about all VCR manufacturers distribute their own brands of cleaning tapes. This one from Arista can be used as a wet or dry cleaner and is recommended for use, by the manufacturer, for every 20 to 30 hours of operation.

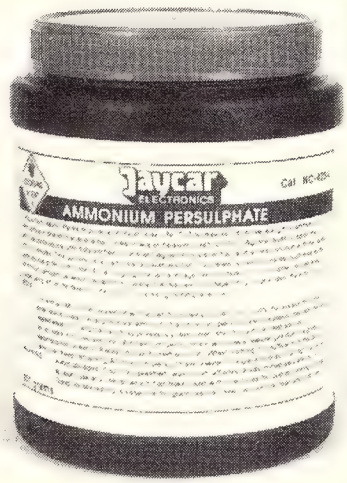
The cleaning tape is not abrasive but consists of a fabric ribbon. The cleaning fluid is applied by squeezing the bottle to apply five or six



drops into the appropriate hole in the cassette. Arista warn that if the tape is used in this latter mode, it may trigger the dew point sensor on some VCRs. For these machines they recommend that the tape be used dry.

The cleaning tapes are available from all Arista outlets.

Handy 400g containers of ammonium persulphate



For those who like to etch their own small printed circuit boards, Jaycar has made available this handy 400g container of ammonium persulphate. Etching instructions are on the label. According to Jaycar, the contents are sufficient to etch typical boards up to 500 sq cm in area. It is available from all Jaycar stores.

Electrolube Air Duster

How often have you wished you had a small air compressor to blow out carburettor jets, small appliances, model train or model car motors or whatever? We certainly have. Now you can have clean compressed air for just these tasks without having to spend several hundred dollars on an air compressor or having to go to the bother of hiring a cylinder of compressed air.

Electrolube Air Duster is the answer. It's an aerosol-powered 550g container of inert gas (we guess it's probably nitrogen) which comes with a small plastic hose to enable the air to be directed where you want it. It gives a good finely focussed blast and is surprisingly effective.

Pardon the pun, but it's a bottler. Priced at $11.95 from Jaycar.

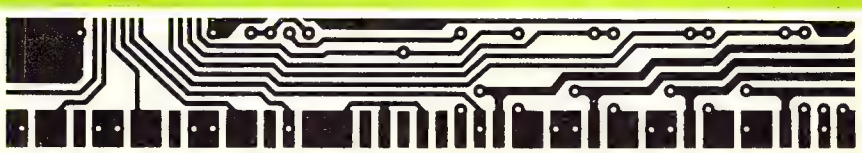
Smoke detector has optical sensor

Some years ago smoke detectors with a radioactive element sensor were on the market but they were withdrawn because of public fears about radiation. This new smoke detector from Arista Electronics Pty Ltd has an optical sensor comprising an infrared light emitting diode and photodiode. When the light path between the two is interrupted by smoke, the alarm is tripped.

It runs from an external supply or its own 9V battery and has its own piezoelectric alarm. It may also be linked to other smoke alarms in a security system or home burglar alarm via two wires. Protruding through the grille of the unit is a test pushbutton and a LED which glows when the unit is tripped.

We found it an effective unit. It is available from all Arista retail outlets.

RCS Radio Pty Ltd



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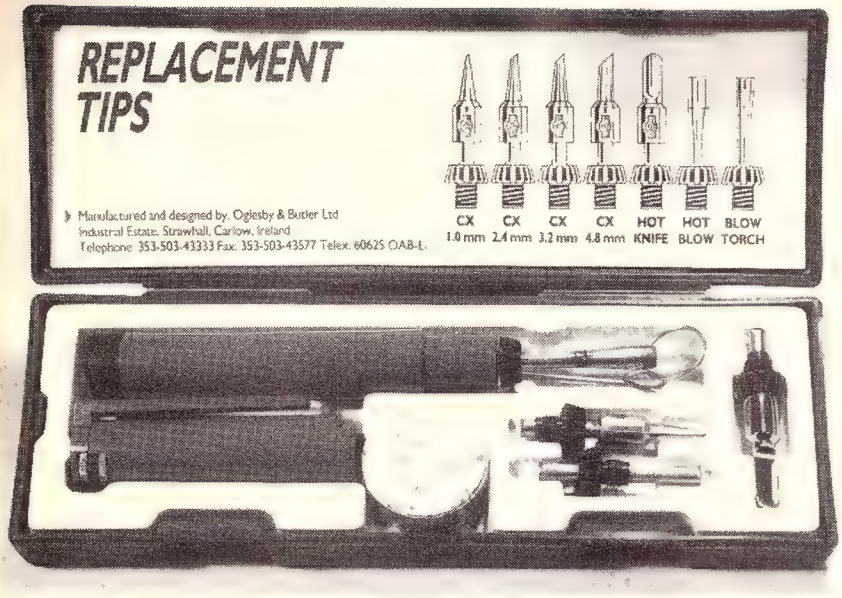


Professional Portasol gas powered soldering iron

Last month we briefly reviewed the standard model Portasol iron and recommended it as a very effective unit for all sorts of situations. Now there is a new version called Professional Portasol. This blue coloured unit comes in a neat plastic case which incorporates a small dish with a piece of foam in it (for wiping the iron's tip), a small wire stand and four accessory tips. One was a standard soldering tip while the other three comprised a hot knife, a hot blower and a mini blow torch.

While the latter accessories are novel they are certainly effective although the unit must be full of butane for best results.

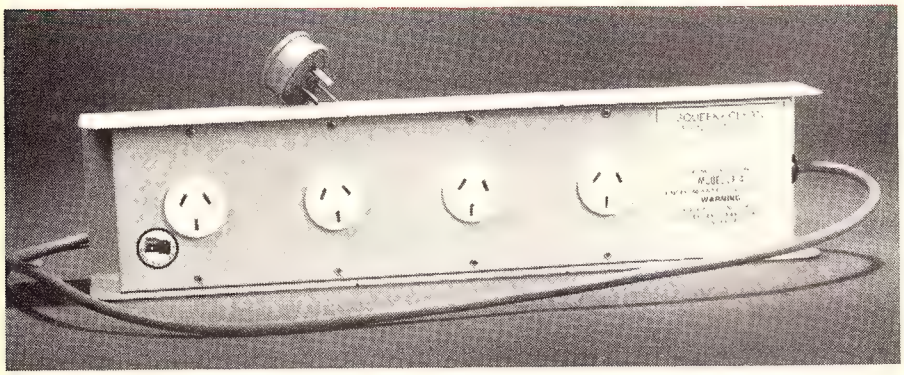
If you have the occasional need for a small blowtorch as well as a gas-powered soldering iron, this Professional Portasol is a bargain. It is available for $81 from Geoff Wood Electronics. Phone (02) 427 1676.

High performance headphone amplifier for CDs

Electromark have a high performance stereo headphone amplifier, the ILP HY67, which would be ideal for use with CD players which do not already have a stereo headphone output. Fully encapsulated, the unit has a signal-to-noise ratio of 100dB, separation between channels of 60dB and total harmonic distortion of less than .01%.

The HY67 can drive typical stereo headphones with impedance from 8Ω to 2kΩ and can be powered from supply rails up to ± 25V DC to obtain a generous output level. As well as being used with domestic compact disc players, the headphone amplifier would be ideal for use with a disco console for cueing.

For further information, contact Electromark Pty Ltd, 40 Barry Ave, Mortdale NSW. Phone (02) 533 4896.



Squeeky clean mains filters

Sooner or later anybody who has a computer system will want a mains suppressor. Transient voltages superimposed on the mains can cause system crashes and data loss. This can be frustrating, time-consuming and expensive.

These filters are made in Australia by KCC and are fully approved by the Energy Authorities. They can be recommended as a source of clean mains power. The two outlet LF-2 is $99 while the four oulet model LF-4 is $269. They are available from Jaycar stores.

Back copies of Silicon Chip

Those readers who missed the first two issues of SILICON CHIP can purchase mint copies from our offices. The highlights of the first issue included the first article on our Digital Frequency Meter, a Capacitance Adaptor for DMMs and an Off-hook Indicator for Telephones. Highlights of the second issue included a fully protected 100 watt power amp module, a 24V to 12V converter for trucks and a passive IR sensor for burglar alarms. For details on how to order, see page 92.

THE WAY I SEE IT

By NEVILLE WILLIAMS

Information has its place — but what about knowledge?

It's possible to assemble any amount of routine information about such things as the steam age, the gramophone era or the birth of radio and hifi in Australia but, sadly and in the normal course of events, many of us carry to the grave a wealth of first-hand knowledge of how things really were, when it was all happening.

You may quibble about my choice of the two key words in the above heading and introduction but by "information" I mean routine references to dates, people, facts and situations which can be found in books, journals, newspapers and documents, much prized by those who delight in researching and reconstructing history — accurately or otherwise.

By "knowledge", on the other hand, I am referring to an innate familiarity based on actual personal experience, or acquired or communicated at that level.

It is important, as I see it, to differentiate between the two, not just in the context of history but of the present and future as well. Let's think about it.

I'm becoming increasingly aware of the distinction, as there seems to be more than usual interest in the past at the moment. You've probably noticed the recurring historic themes on television, the emphasis on restored buildings, the proliferation of antique dealers in country towns, and so on.

Doubtless, some of this can be put down to nostalgia, fond memories of times and situations where people may have felt better able to cope. But, beyond that, the past has its own unique interest, and its own unique value as a reference with which to compare the present and the future.

ABC's "Talking History"

For me, the matter was brought into focus when I was contacted by Stephen Rapley, presenter for the ABC's Social History Unit. Their program series "Talking History" is currently being broadcast over ABC Radio National and by satellite to regional centres each Saturday after the 1.30pm news (1.00pm in South Australia).

The series covers a whole range of subjects of social historical interest, but Stephen Rapley has most recently been researching for a future presentation on "Radio and Telecommunications" in Australia.

At least that is the formal subject title in the ABC's "Talking History" brochure. In a news item published in the September IREE "Monitor", interest was expressed in topics such as the contribution of Australia's pioneer wireless amateurs and engineers, the emergence of broadcast stations in the early '20s, local receiver manufacture from the same period, the Royal Flying Doctor Service, the School of the Air, the vital role of telecommunications in Australia's development, the impact of television, the FM story and so on.

When he subsequently called to see me, Stephen Rapley explained the philosophy behind the series in more detail. Dates and facts have their rightful place, he said, but on their own they're pretty dry fare, especially for broadcasting.

The idea behind "Talking History" or oral history, if you like, is to record for posterity the voices and the impressions of people who were actually involved in or lived through the relevant periods. Their stories and their first-hand account of events and situations can breathe life into regular but often dry documented information.

Putting his theories into action over morning tea, Stephen encouraged me to reminisce about my life as a lad in a small country town, dependent for amusement and information in those days on purely local sources. We had no telephone, no gramophone, no wireless and only irregular, shared newspapers.

Talking "historians"?

How did we occupy our time in the evenings? As kids, I said, we did our chores and played with other kids until dark during the summer, sat around shivering during the winter and went off to bed with a

No runaround — when it was most needed!

The first two articles in this series carried stories of people who had received the runaround instead of prompt electronic service. This story has a different slant. It concerns a disabled pensioner lady who wanted a "runaround" and couldn't get it.

The runaround in question is an electric motorised wheelchair on which she depends for mobility outside the house. With its help, she can do shopping or attend the occasional social gathering. But recently, in the middle of such an outing, the drive system went dead and she and her chair had to be brought back home in a neighbour's panel van.

Rather nervous about the cost of getting it fixed, she rang the local agent, who suggested that the fault was probably in the speed control system. It was concentrated on an easily removeable component board and it might be possible to have it removed by someone on the spot and sent in for checking. This she was about to arrange.

When the board was duly removed, it was draped with the exploded remains of what had apparently been an electrolytic capacitor but there was no way of telling whether this had been the cause of the breakdown or the result of it.

Sufficient to say, the board was despatched to the agent forthwith for what he had tipped to be a couple of hours' work. However, when she rang a few days later to inquire about progress, she was told that it had been sent interstate to their central service centre.

When she had still heard nothing a couple of weeks later, she wrote direct to the service centre, who phoned her back to say that the unit had been extensively damaged by someone having reversed the connections to the battery — this, despite her insistence that the chair had been operating normally for months and that the breakdown had occurred quite spontaneously.

As far as they could tell from their paperwork, the board had been repaired and despatched; it must have gone astray somewhere. They'd have to check around and let her know in due course.

Where they looked and where they found the board they never admitted but the local agent did ultimately ring to say that it had just been despatched. In the meantime, she'd been sitting around for five full weeks waiting for someone to do a two-hour job!

It could just be that there's a bright side to the story: she's had the runaround now for two weeks or more, without any sign of the bill. "Maybe they've also mislaid the paperwork", she said, "or they may feel bad enough about it not to charge me for replacing the little gadget".

Time will tell!

warm iron wrapped up in a towel at our feet!

When did I first hear a wireless set? On headphones or a loudspeaker? What was it like when we got a set of our own? What were those early receivers like? How did a country boy come to get involved in radio as a career? What was it like, working in a '30s style radio factory? And so on.

None of this was actually recorded. As I talked, Stephen Rapley scribbled industriously in his note pad and fired back more prompts and more questions. He was identifying possible subject themes to be pursued and developed in the weeks that followed.

Finally, what about other people with whom I had shared the wireless, radio, hifi and TV scene during my working life? And here I must confess to "dobbing in" a few associates from past days — cautiously, because I was not in all cases aware of their present circumstances. But some, I knew, had a story to tell. For example:

- Winston Muscio, ex STC & BSR, author of "Australian Radio — the Technical Story"? "I already have some source material from him on tape", said Stephen R.
- Neville Thiele, of vented enclosure fame, prominent EMI engineer, more recently retired from the ABC? "Initial contact had already been made".
- Ernest Benson, former AWA engineer/editor, writer and lecturer and pioneer electronic organ enthusiast? "How do I get in touch?"
- Reg Boyle, retired PMG senior engineer, who saw broadcasting and telecommunications from the inside? "I've already made contact with him through the IREE".

There were other long-time acquaintances who came to mind as we chatted and doubtless, still others who will respond positively to the news item in the IREE "Monitor". If you want to follow it up, Stephen Rapley can be contacted at the Social History Unit, ABC Radio, GPO Box 9994, Sydney, NSW 2001 (Phone 02 339 0211, Ext 2683).

Typical recording session

In my case, Stephen Rapley's intention had been to record a more structured but still informal chat in my own home but intermittent traffic noise put paid to that. We ended up in an ABC studio in William St, Sydney, for the best part of three hours while I responded to questions and prompts, some from the interviewer's notes, others quite spontaneous, arising from what had just been said.

I found myself having to explain the uncertainty about the time of day in the pre-wireless era. How domestic mantel clocks would vary with the temperature and whether or not they had been inadvertently under-wound or over-wound. How they could be 10-15 minutes out and we wouldn't know, unless somebody noticed the clock in the stationmaster's office on the way home and worked out that ours just had to be wrong.

The chiming town clock? The nearest one would have been eleven miles (18km) of rutted road away! Wireless solved that pro-

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blem, as well as providing up-to-date (though not always accurate) weather reports.

I recalled searching the scrub with my father for a couple of tall saplings to support the mandatory 30ft (10m) high aerial; contriving an effective earth in parched ground and adding a lightning arrester — vital in an area prone to thunderstorms and virtually devoid of other overhead wires.

Oh yes, and the need to ration family listening to one or two broadcasts a day. Why? To conserve batteries — because in those days a set of new batteries, railed from the city, could make an awful mess of a week's wages!

Mention of a week's wages prompted further recollection of the dismay when the primary winding of one of the interstage transformers in the family Colmovox burned out. What did my father do but carefully dismantle the whole thing, unwinding thousands of turns of hair-fine wire until he had located and repaired the break. Then he successfully rewound it, entirely by hand — a feat at which I still boggle.

Reliving these and many other such situations, it became abundantly evident how far removed the ABC's "talking history" was from the documented information that broadcasting stations commenced operation at certain times and places, allowing battery-powered receivers of the period to bring news, weather reports and entertainment to hitherto isolated listeners.

How much of the recorded material gets to air, or in what form, is not for me to say. The present intention is to edit selected segments into suitably instructive and hopefully entertaining sessions, after which the master tapes will be passed over to the national archives. Contrast that with the following.

Are computers addictive?

While involved in this and other historically oriented projects, I've had reason to chase through sundry references in an effort to pinpoint particular events and dates. You know how it is: you're certain you have the information somewhere; you remember having seen it when looking for something else; now you can't find it!

Wouldn't it be great to have it on computer? You could simply put it up on screen, scan through it yourself or, easier still, request the computer to find this, that or the other for you — which it can do in seconds flat!

So, one wet and lazy day, I reached down my copy of the Macquarie "Book of Events" and abridged the contents of the chapter on "Radio & Television" into a series of one line entries into the computer.

It looked promising, even in that very abridged form and, since then, I've dropped in quite a few more dates and events as I came across them. Providing I don't decide to do it some other way, the list seems all set to grow like the proverbial Topsy. The main reason why it hasn't already reached maturity is that I've had to give priority to other, more urgent tasks.

But I'm conscious that the embryo list has a certain on-going fascination (did I say addiction?); a compulsion to generate an original personalised chronological listing, almost as an end in itself. This, despite the fact that a long list of dates and abridged information on a computer screen is deadly dull!

A comprehensive list would undoubtedly prove very useful but, in the process of its compilation, I personally would become little the wiser. By its use, I might even become the poorer for not having occasionally to search through the literature and be reminded of other things in the process.

The way I see it, instant access to computerised information must be seen as an efficient tool in the execution of certain tasks. In no sense is it a substitute for assimilated knowledge or innate knowledge of the kind possessed by people who have "been there and done that"!

My own embryo dates/events list could be regarded as a miniature version of a much wider scene. Any number of computer databases already exist out there, with the largest collection of information stored in a publicly accessible computer, in Australia, being that in "CSX", maintained by the CSIRO.

The overall system is reputedly so large and diverse that the people who have access to it are said to understand only the part which they actually use. It is doubtful whether anyone is aware of its total contents.

I gather that much the same applies to other larger databases around the world for the same basic reason: like CSX, they have simply grown over a period of time, without sufficient attention having been given to the problem of gaining easy access to all the information that has accumulated. For most private computer users though, databases are still something that they read about.

But massive changes in the recording and dissemination of information are already visible on the horizon. Huge quantities of reference information can now be stored on derivatives of the compact disc — typically more than 500 gigabytes per disc, equivalent to 150,000 pages of printed A4 text or a complete set of a large encyclopaedia.

Grolier's American Academic Encyclopaedia has already been transferred to a single disc (words only) while the UK-based Commonwealth Agricultural Bureau has been making its database abstracts available on CD-ROM on a 2-year subscription basis — although currently a rather expensive option.

It will only be a matter of time though, before these databases become available at a price within reach of most people with access to a suitably specified CD player and personal computer.

About then, we will have entered the era of what Gareth Powell, computer feature writer for the *Sydney Morning Herald*, has variously described as hyperlearning, hyperteaching, hyperwriting, hyper-reading, or hyperfiling. Oddly, and according to my dictionary, the prefix "hyper" means "over", implying excess or exaggeration.

That aside, I'll go along with the terms hyperwriting and hyperfiling, because they imply a staggering concentration of information. That it certainly would be, or is.

But these terms get back to my earlier objection. Access to a huge amount of information may be both practical and useful to those who need it for specific reasons, but it has no 1:1 connection with acquisition, as implied by reading, teaching or learning; in short, with acquired knowledge.

In case you feel that I am expressing a purely personal view, let me quote a systems manager with whom I discussed the generalities of computer databases: "It is important to realise that they are simply capacious data files ... sources of information ... nothing more."

How many families already display in their living rooms a nicely bound multi-volume encyclopaedia, containing a wealth of information? It could be the source of considerable knowledge but may not, in fact, be consulted from one year to the next.

Is there any reason then why electronic encyclopaedias and databases should be any different, whether on disc or at the end of an incoming fibre optic cable?

I'm not averse to encyclopaedias and databases on chips or discs but please, don't let's confuse mere access to information with knowledge, however acquired.

Is there any real basis for such apprehension? Is there any indication of data being substituted for knowledge? I believe there is, right here in our own industry.

Electronic "Living History", 1987 style, can still call on people who, in their day, shared at first hand in the application of basic technology; who were involved in the design and production of everything from small components, through consumer equipment to the largest transmitters; who enjoyed an easy rapport with their peers from overseas.

Next time around, another Stephen Rapley may be less fortunate. The old timers may remember the trends, components and user manuals imported from overseas but, apart from a few isolated high-tech areas, innate knowledge will be a rare commodity.

That's the way I see it! ☙

Personal Phone Ringer — ctd from p.25

natural resonance of the transducer.

You can also vary the frequency of modulation of the oscillator by using different values for Cs although we assume that most constructors will stick with the value of 0.1μF which we have nominated.

Installation

Installing your new phone ringer is easy. Just identify the connections to the bell ringer coil(s) and substitute the two leads to the phone ringer instead. Before you make the connections though, you should work out where and how to mount both the printed circuit board and the piezo transducer. This will take some ingenuity in some cases because even though there is usually quite a lot of waste space inside most phones, much of it is unusable.

On the Telecom 800-series telephones which are installed in most homes, the bell ringer coil is connected between terminals P1 and GS5. To disable the internal bell, we suggest you connect both ringer coil leads to P1 and then wire the new ringer circuit between P1 and GS5. Doing it this way makes it easy to restore the phone to original condition if necessary.

We installed our prototype in an 800 series phone by glueing the board to one of the flat metal pillars which support the dial mechanism, The piezo ringer was then glued edge-on to the base plate close by. Five-minute epoxy was the adhesive used. Tricky, huh?

Incidentally, glueing the transducer edge-on renders it louder than if it is secured on the flat. The end result was quite a bit louder than the original bells so we detuned it a little by adjusting the trimpot.

As a final note, this circuit can be used as an alarm wherever a DC voltage of 20 to 30 volts is available. It is loud, arresting but not unpleasant and its current consumption is low, at around 1mA. ☙

DIGITAL FUNDAMENTALS

In this chapter, we look at the circuits that make up the various logic elements and discuss their operation. We also look at the various logic families; and we test your knowledge.

LESSON 3: DIGITAL CIRCUITS

By Louis E. Frenzel, Jr.

In the previous lesson, we introduced the basic digital logic elements, such as the inverter, AND gate, OR gate, and NAND and NOR gates. These are the basic logic elements that process binary signals in digital equipment. We discussed their operation in terms of the logic functions they perform and the operation of each was expressed in Boolean algebra, truth tables, and timing diagrams. Only logic symbols were used to illustrate those devices. In this lesson though, we want to take a look inside the logic symbols.

There are two basic methods of implementing digital circuits: discrete and integrated. Discrete component circuits are those made up of individual transistors, resistors, diodes, capacitors and other components wired together on a printed circuit board. The integrated circuit has all the components together on a tiny chip of silicon.

Today, most digital circuits you will encounter will be of the integrated circuit form. Occasionally, however, you will run across a discrete component circuit in an older piece of equipment or in one requiring some special or simple function. We will discuss both ICs and discrete component circuits in this lesson.

Inverters

Let's begin our discussion with the circuit used to make a logic inverter. We will talk about simple discrete-component circuits first and that knowledge will easily translate to integrated circuits. For our discussion here, zero volts or ground represents a *binary 0* and + 5V DC represents a *binary 1*.

The main element in an inverter circuit is a switch as shown in Fig.1a. The switch is connected in series with a resistor to the supply voltage. A binary input

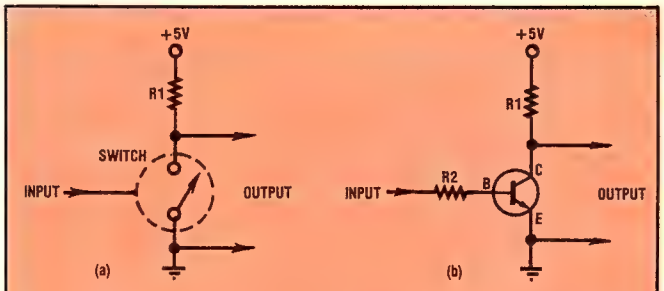


Fig.1: a logic inverter operates like a shunt switch (a) in parallel with the output. A transistor (b) operated at cut-off and saturation functions in the same manner.

signal controls the operation of the switch and the binary output appears across the switch. When the input is binary 0, the switch is open. The output, therefore, is + 5V or binary 1.

If the input is binary 1, the switch is closed. Current flows through the switch and resistor R1. The output is 0 volts or binary 0, because the resistance of the switch is near zero.

A common bipolar transistor can be used as the switch to form a simple inverter as shown in Fig.1b. A transistor works well in this application because it can be turned off so that no current flows through it, or it can be turned on to let current flow through it.

Recall that there are three basic operational states of a bipolar transistor: cut off or non-conducting, conducting in the linear region, and saturation. Those states are achieved by biasing (see Review of Diode and Transistor Biasing). When the transistor is cut off, it is non-conducting and acts as an open circuit.

With the proper bias on the transistor, it conducts

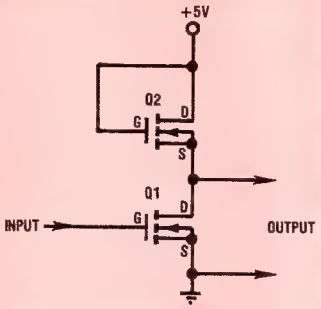


Fig.2: a MOSFET inverter (Q1) using a MOSFET (Q2) as a load in place of a power-consuming resistor.

in the linear region. This means that the collector current is directly proportional to variations in the base current. That permits a small base current to control a large collector current and thus cause amplification to take place. The linear conducting mode is not generally used in digital electronics.

If sufficiently high bias current is applied to the base of the transistor it will conduct *hard* and act as a very low resistance. During that time both the emitter-base and base-collector junctions are forward biased. The voltage drop between the collector and emitter at that time is extremely low; therefore, the transistor appears to be a virtual short circuit. When in saturation, the transistor acts as a closed switch.

Using those principles, the operation of the inverter is easy to understand. If the input to the inverter in Fig.1b is 0V or ground, the base-emitter junction of the transistor will not be forward biased. No current will flow through R1 or the transistor. The transistor thus appears to be an open circuit. Therefore the output is + 5V or binary 1 as seen through R1.

When a binary 1 or + 5V signal is applied to the input, the base-emitter junction is forward biased. The value of resistor R2 is made low enough so that the base current is high enough for the transistor to saturate. During this time, the transistor acts as a very low resistance. A typical output voltage between collector and emitter might be 100 millivolts (100mV). This is sufficiently low so as to represent a binary 0.

Metal oxide semiconductor field-effect transistors (MOSFETs) can also be used to form an inverter as shown in Fig.2. Here N-channel enhancement mode MOSFETs are used. Q1 is the inverter switch while Q2 acts as the load resistor. This technique is widely used in N-channel MOS (metal oxide semiconductor) integrated circuits. Transistor loads are easy to make in integrated circuit form and also take up much less space than an integrated resistor.

An enhancement mode MOSFET may also act as a switch. When its gate voltage is below some threshold voltage (about + 1.5 volts in common N-channel MOSFETs), the transistor is cut off. It acts as an open switch. When a positive logic signal above the threshold value is applied to the gate, the transistor conducts; therefore it acts as a closed switch.

The operation of the inverter in Fig.2 is simple. When the input voltage is binary 0 (near 0V), transistor Q1 does not conduct. Q2, however, is conducting because it is biased on. The output voltage is, therefore, + 5V as seen through Q2.

When the input voltage is a binary 1 level or approximately + 5V, Q1 conducts. It acts as a very low resistance; therefore, little voltage is dropped across it. The output voltage is near 0V or binary 0.

AND and OR Gates

AND and OR gates can be constructed with diodes and resistors. For example, a simple OR gate is illustrated in Fig.3. If both inputs to the OR gate are binary 0 or ground, neither diode conducts and no current flows through resistor R1. The output, therefore, is at 0V or ground as seen through R1.

If both inputs are binary 1, both diodes D1 and D2 conduct. Current flows through resistor R1. The output, therefore, is a binary 1. Most of the voltage applied to the inputs will appear across R1 except approximately 0.7V which is dropped across each diode. With a + 5V input, the output would be approximately + 4.3V.

If one input is binary 0 and the other binary 1, the output will also be binary 1. For example, if input A is + 5V and input B is 0V, diode D1 in Fig.3 will conduct. The output will be approximately + 4.3V. That will cause diode D2 to be reverse biased and it will be cut off.

A simple discrete-component AND gate is shown in Fig.4. If both inputs are binary 0 or ground, both diodes D1 and D2 conduct. Current flows through R1. The output voltage at that point is the voltage drop across the diodes. For a typical silicon diode, the voltage drop will be approximately 0.7V. That is a low-level voltage and represents a binary 0.

If one input is binary 0 and the other is binary 1, the output will also be binary 0. For example, if input A is binary 0 and input B is binary 1 or + 5V, diode D1 conducts. The output will be approximately + 0.7V. This means that diode D2 will be reverse biased and, therefore, cut off.

If both inputs are binary 1 or + 5V, both diodes conduct. The output will be + 5V less the voltage drop

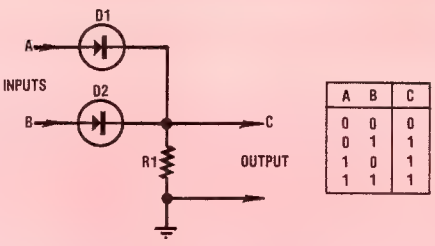


Fig.3: simple diode OR gate and its truth table.

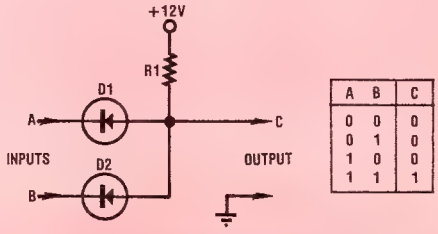


Fig.4: diode AND gate and its truth table.

across the diodes. If the inputs are + 5V, then the output will be + 4.3V or binary 1.

If both circuits are as shown in Figs.3 and 4, additional diodes may be added to accommodate more inputs as needed. Furthermore, those simple circuits can be combined with inverters to implement almost any logic function. However, discrete component circuits take up a lot of space and are inconvenient to construct. Their performance is also generally poor. For that reason, they are used only where simple non-critical circuits are needed.

Digital Integrated Circuits

Virtually all pieces of digital equipment are built these days using integrated circuits. An integrated circuit is one in which all the components — including transistors, diodes, resistors and capacitors — are fully formed and interconnected on a tiny silicon chip. Many inverters, logic gates, flipflops, and other logic and linear circuits can be contained within a small area.

A typical silicon chip is roughly square, with sides of approximately 2.5 to 6mm. The smaller chips contain several gates or inverters while the larger chips might contain a complex circuit such as a microprocessor. The chip is encapsulated in a special package with leads that can be plugged into a socket or soldered to a printed circuit board. The most popular form of package is the dual-in-line package, or DIP (see Fig.5), which may have 8 to 64 pins.

Digital integrated circuits are generally divided into four basic categories: SSI, MSI, LSI and VLSI. Those designations, described in Table 1, show how digital

Fig.5: dual in-line package (DIP) for integrated circuits.

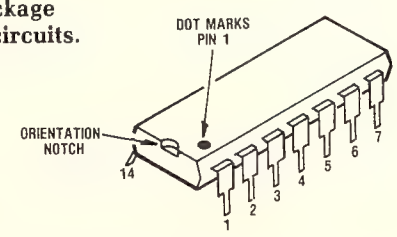


TABLE 1
LEVEL OF ICs BASED ON CIRCUIT DENSITY

SSI	Small-Scale Integration: Chips containing 12 or less gates, inverters, flipflops etc.
MSI	Medium-Scale Integration: Chips containing 12 to 100 gates, inverters, flipflops etc, usually connected as functional circuits that do something such as counters, registers, decoders, multiplexers, and many others.
LSI	Large-Scale Integration: Chips with 100+ gates, flipflops etc, often forming complete circuits such as microprocessors, program and control circuits, and many others.
VLSI	Very Large-Scale Integration: Chips with 1000+ gates, flipflops and other circuits such as 32-bit microprocessors, data acquisition systems, gate arrays and much more.

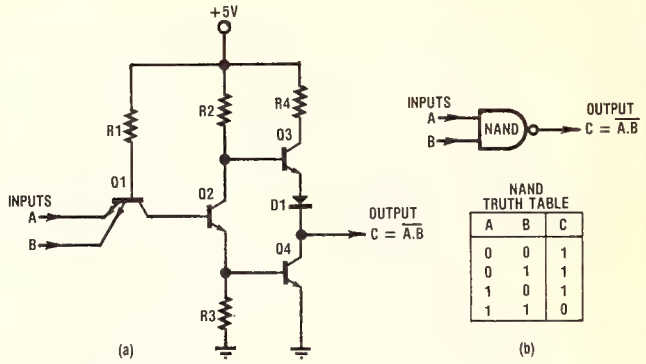


Fig.6: simplified TTL NAND gate circuit (a), and its schematic symbol (b) and truth table.

ICs are classified according to size, density and function.

Digital ICs are also classified by the type of transistors used in their circuitry. The two basic types are bipolar and MOSFET. IC manufacturers have developed a wide range of digital IC families using both types of transistors. Typical bipolar families include resistor-transistor logic (RTL), diode-transistor logic (DTL), transistor-transistor logic (TTL), emitter-coupled logic (ECL), integrated-injection logic (I^2L) and several others.

RTL and DTL aren't used any more in new designs, but you may occasionally find them in older equipment. TTL and ECL are widely used today while I^2L circuits are common in LSI and VLSI designs.

MOS logic families include P-channel and N-channel MOS and complementary MOS (CMOS). Because bipolar circuits are larger and consume more power, they take up more space on a silicon chip and, therefore, are used primarily for SSI and MSI circuits. Most LSI and VLSI circuits are MOS or CMOS.

In this lesson we are going to talk about the most popular forms of logic today, TTL and CMOS.

Transistor/Transistor Logic

Probably the most popular form of SSI and MSI digitial ICs is transistor/transistor logic (TTL). TTL is used in everything from personal computers to the most advanced avionics equipment.

TTL circuits use bipolar transistors and operate on a power supply voltage of + 5V DC.

The basic TTL logic circuit is illustrated in Fig.6. That particular circuit performs the positive logic NAND function. However, other versions are available to perform the AND, OR and NOR functions. A single input version of the circuit is used as an inverter.

The circuit has three parts: a multiple emitter-input transistor (Q1), a phase splitter transistor (Q2), and the output stage (Q3 and Q4). Refer to Fig.6a. Transistor Q1 and R1 function as a simple diode AND gate where the emitter-base junctions of Q1 are diodes. The main purpose of phase splitter Q2 is to furnish complementary logic signals to the two output transistors Q3 and Q4.

Q4 is the output switching transistor and performs the function of an inverter while Q3, along with D1 and R4, forms an active pull-up stage. It is similar in

operation to the MOSFET load resistor described earlier.

Some TTL circuits are available without the active pull-up stage. Q3, D1 and R4 are eliminated and the collector of Q4 is brought out to one of the DIP pins. An external load must be connected. Open collector circuits are useful for driving components such as LED indicators, relays and other external circuits.

In most cases the active pull-up circuit is preferred, because it represents a very low impedance when the output of the gate is binary 1. That permits the circuit to quickly charge any external capacitance, thereby greatly reducing the rise time and speeding up the circuit.

The logic levels for the typical TTL circuit are 0V to +0.8V for binary 0 and +2.4V to +5V for binary 1.

Now let's see how the TTL circuit functions. Remember that it is a NAND circuit. You can refresh your memory about how it works by referring to the truth table in Fig.6b. Assume that either or both inputs A and B are at ground or binary 0. The corresponding emitter-base junctions of Q1 then conduct through R1. When Q1 is conducting, it pulls the base of Q2 to almost 0V and so Q2 is cut off.

As a result, base current is supplied through R2 to Q3 which conducts. Transistor Q4 is cut off at that time. The output voltage will be +5V less the voltages dropped across R4, Q3 and D1. This output voltage is typically in the +2.4V to +3.6V range.

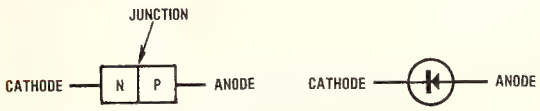
If both inputs are binary 1, the base-emitter junctions of Q1 do not conduct. However, the base-collector junction of Q1 does conduct and provides base current to Q2 and through Q4. Transistor Q4 saturates and effectively brings the output to near ground level.

The most popular form of TTL is the 7400 series which provides of all of the commonly used logic functions.

The individual ICs are usually labelled with the manufacturer's logo, the device type number, and a

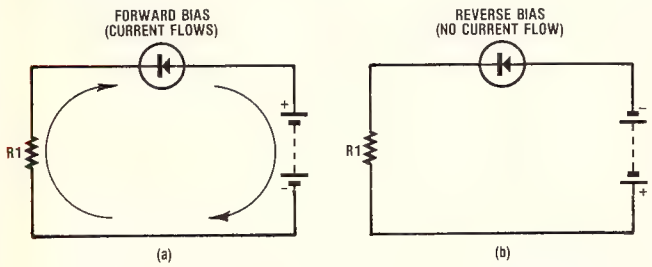
REVIEW OF DIODE AND TRANSISTOR BIASING

Diodes and bipolar transistors are made by combining N— and P-type semiconductor materials (silicon, germanium, gallium arsenide) to form *junctions*. A PN junction creates a diode.



The diode symbol (above) is used in schematic diagrams.

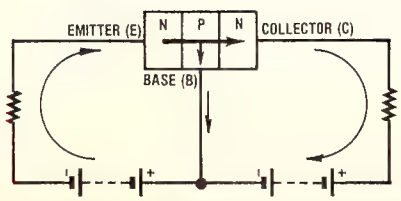
The current flowing in a diode depends on its *bias*, an externally applied voltage. The circuits show the two ways to bias a diode.



If the cathode (N-type material) is made negative with respect to the anode as shown at A, the diode is *forward* biased and it conducts. The amount of current flowing is controlled by the resistive value of R1.

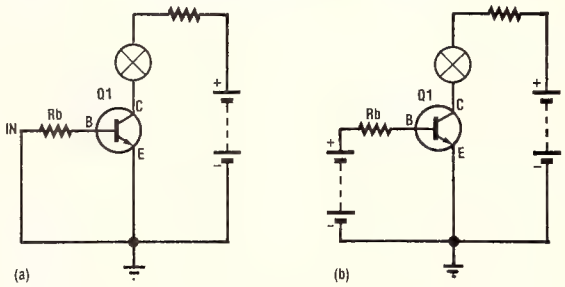
If the cathode is made positive with respect to the anode as shown in B above, the diode is *reverse* biased. No current flows in the circuit.

Transistor biasing follows similar rules. An *NPN* transistor is illustrated below.



If the *base-emitter* junction is forward biased and the *base-collector* junction is reverse biased, the transistor conducts. This is the normal condition for a transistor operating in the linear region for amplification.

In logic and switching applications, the bias arrangements shown below are used. Here the transistor is used as a switch to turn on an incandescent bulb.



If the input is grounded as in A, the base-emitter junction is not forward biased. Therefore, the transistor does not conduct and the bulb does not light. If the base is made positive as shown in B, the base-emitter junction is forward biased. The base-collector junction is reverse biased so the transistor conducts and the bulb lights.

If the base current is made high as determined by Rb, the transistor will conduct *hard*. Its *collector-to-emitter* resistance will be very low and only a small voltage will appear between the collector and emitter. The collector may only be +0.1V with respect to the emitter at ground. With the base-emitter junction forward biased and conducting, the voltage across it will be the same as a conducting diode or about +0.7V.

If the base is +0.7V with respect to the emitter or ground and the emitter is +0.1V, then the base is positive with respect to the collector. This means that the base-collector junction is forward biased also. This condition is caused by high base drive. When both junctions are forward biased, the transistor is said to be *saturated*. Saturated operation is typical in bipolar transistor logic circuits.

date code. Each of the TTL manufacturers such as TI, Fairchild, Signetics, National Semiconductor, and others, has its own special company symbol. The part number designates the specific device. For example, a 7430 is a single 8-input NAND gate.

Propagation delay

Propagation delay is the time that it takes a logic change at the input to propagate through the device and appear as a logic-level change at the output (see Fig.7). For TTL circuits the propagation delays are generally in the 2 to 30 nanosecond range and operating frequencies up to 125MHz are possible.

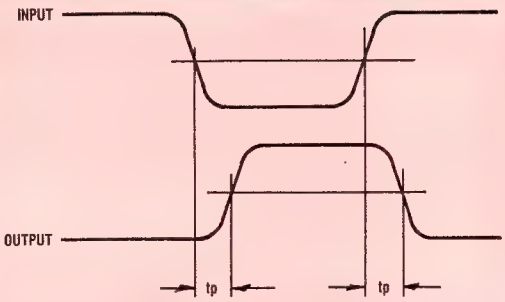


Fig.7: propagation delay is defined as the time offset between input and output logic level transitions.

Power dissipation is another important parameter. The lower the power consumption, the better. However, the faster the circuit, the more power it consumes. Most common TTL circuits have a power consumption in the 1-25 milliwatt (mW) range per gate.

Going faster

Some TTL circuits use Schottky diodes to speed up circuits while reducing power consumption. Essentially, each transistor in the circuit has a Schottky diode connected between the base and collector as shown in Fig.8.

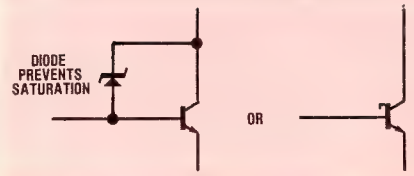


Fig.8: schematic diagram of a Schottky transistor.

When saturated transistors are used in an IC, it takes a finite amount of time for the circuit to turn off. That condition, known as *charge-storage* puts a limit on the speed of operation. However, if a Schottky diode is used, saturation does not occur and there is no charge storage problem. As a result, switching speeds are faster and propagation delays are lower. However, standard Schottky TTL circuits have relatively high power consumption.

The most popular TTL circuits today are the so-called low-power Schottky devices that have propagation delays as low as two nanoseconds. Those ICs are designated by an LS in their part number (ie, 74LS20).

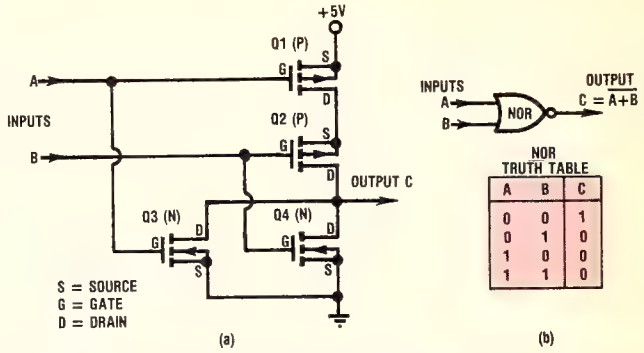


Fig.9: schematic diagram of a CMOS NOR gate (a), and its schematic symbol (b) and truth table.

Complementary MOS

Another popular family of SSI and MSI logic circuits is complementary MOS or CMOS. CMOS circuits use both P-channel and N-channel MOSFETs, thus the prefix C for *complementary*.

The power supply voltage is typically +5V, although most CMOS circuits can operate reliably with supply voltages in the +3V to +18V range.

Fig.9a shows the basic CMOS logic gate which performs the NOR function as indicated by the symbol and truth table in Fig.9b. Note that Q1 and Q2 are P-channel MOSFETs while Q3 and Q4 are N-channel MOSFETs. All four transistors are enhancement-mode MOSFETs meaning that the transistor is normally off until the threshold gate voltage is exceeded with a logic input signal.

Now let's see how that CMOS NOR circuit operates. Assume logic levels of 0V and +5V for binary 0 and binary 1, respectively.

Keep in mind that in order for an N-channel MOSFET to conduct, its gate voltage must be positive with respect to its source. Usually the threshold value is approximately +1.5V. Any input voltage greater than that will cause the transistor to conduct. Otherwise, the transistor will be off. In P-channel MOSFETs, the gate must be made negative with respect to the source. Again, the threshold value must be observed.

Referring to Fig.9a, assume that both inputs A and B are at 0V or at ground potential. Since ground is more negative than +5V, the gates are negative with respect to the sources so both Q1 and Q2 conduct. Q3 and Q4 will be cut off at that time, because their gates are at 0V and below the threshold level. As a result, the output will be +5V as seen through Q1 and Q2.

If either input A or B is binary 0 while the other is +5V or binary 1, then either one but not both transistors Q1 and Q2 will conduct. For example, if input A is 0V and input B is +5V, Q1 will conduct but Q2 will be cut off. If input B is binary 1, Q2 will be cut off but Q4 will conduct. With Q4 conducting, the output will be binary 0.

With both inputs binary 1, both Q1 and Q2 are cut off. However, both Q3 and Q4 will conduct, keeping the output at binary 0. The truth table sums up all possible conditions of inputs and outputs of the NOR gate. Naturally, additional inputs and transistors may

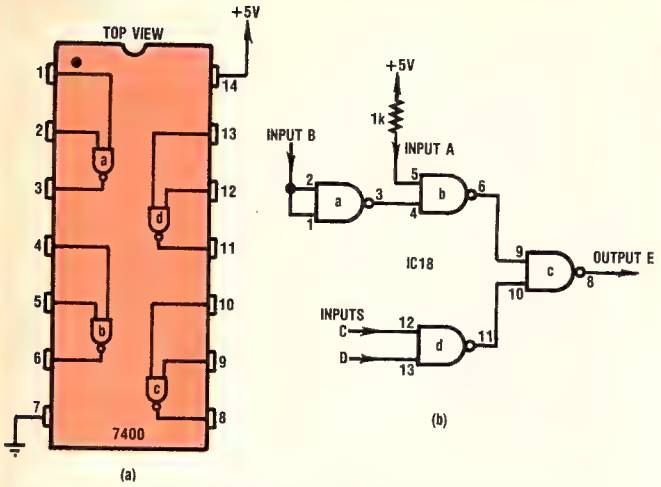


Fig.10: schematic diagram of a TTL quad 2-input NAND gate (a) and a logic circuit made from the quad sections of a 7400 IC (b).

be added to create gates with 3, 4 or 8 inputs.

CMOS ICs are very popular because of their very low power consumption. The only time current really flows in the circuit is while the output switches from one state to the another. The power dissipation of a typical gate is in the 10-nanowatt range. This is very low power consumption and makes power supplies simpler and cheaper, and heat dissipation from the IC practically non-existent.

Even though low power consumption is the primary virtue of CMOS circuits, that does not mean that they are necessarily slow. They are typically slower than TTL circuits, but fast enough for many applications.

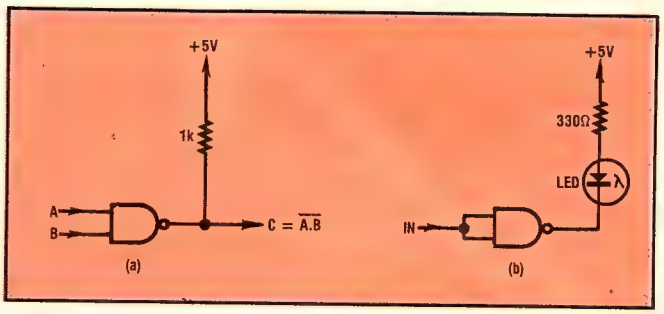


Fig.11: using a 7401 open-collector 2-input NAND integrated circuit as a NAND (a), and as an inverter LED driver (b).

Typical propagation delays are in the 10 to 50 nanosecond range.

Another advantage of CMOS circuits is their high noise immunity. That means they essentially ignore any extraneous signal, pulse, glitch or undesirable input. As a result, CMOS is excellent for use in industrial and automotive applications where high noise is common.

The two most popular lines of CMOS circuits are the RCA 4000 series and the Motorola 14000 series. Both have a wide variety of gates, flipflops, inverters and functional logic circuits such as counters, registers, multiplexers, decoders and others.

Using Logic Gates

Fig.10 shows how TTL gates are used. Fig.10a illustrates a common TTL IC, the popular 7400 quad

SHORT QUIZ ON DIGITAL FUNDAMENTALS — LESSON 3

1. In logic circuits, the transistor is used as a:
   a. resistor b. diode
   c. switch d. capacitor

2. When both junctions of a bipolar transistor are forward biased, the transistor is said to be_____

3. To save space on an integrated-circuit chip, a _____ is used as a pull-up or load in a MOS inverter.

4. The basic TTL gate performs which logic function:
   a. AND b. NAND
   c. OR d. NOR

5. The inputs to a 7400 TTL gate are +0.1 and +3.8V. The output will be:
   a. binary 0 b. binary 1
   c. no change d. not enough information

6. Which of the following is not a type of bipolar logic?
   a. NMOS b. ECL
   c. RTL d. DTL

7. Logic circuits using both N-channel and P-channel MOSFETs are called _____ MOS.

8. An enhancement mode N-channel MOSFET has a threshold of +1.5V. The gate voltage is +0.7V with respect to the source. The MOSFET is:
   a. cut off b. conducting

9. The most popular form of TTL has high values of circuit resistors and uses diodes between the base and collectors of the transistors to prevent saturation. This kind of TTL is called ___ ___ ___.

10. The primary advantage of CMOS is:
   a. low cost b. low propagation delay
   c. low noise margin d. low power consumption

11. TTL is slower than CMOS.
   a. True b. False

ANSWERS

1. c. switch
2. saturated
3. MOSFET (metal oxide semiconductor field effect transistor)
4. b. NAND
5. b. binary
6. a. NMOS
7. complementary
8. cut off
9. low power Schottky
10. d. low power consumption
11. b. false

2-input NAND while Fig.10b shows a typical logic circuit using it.

Note that unused inputs should be connected together and to the supply voltage via a resistor to avoid extraneous input signals.

Fig.11 shows another IC circuit application, using a 7401. This is similar to the 7400 in that it is a quad 2-input NAND. However, the outputs are all open collector, meaning that they require an external load or pull-up resistor. The pull-up resistor is shown in Fig.11a.

Fig.11b shows how the gate is used as an inverter and LED driver. The output load is a LED with a resistor to set the current value. When the input is low (binary 0), the output is high and the LED is off. If the input is high (binary 1), the output is low and the LED turns on.

A CMOS circuit application using a 4001 quad 2-input gate is shown in Fig.12. With two of its inputs wired together a gate becomes an inverter (Fig.12b). Two gates wired as inverters can be connected to form a simple astable multivibrator, usually called a clock circuit (Fig.12c). The output is a continuous rectangular pulse train with frequency determined by the values of resistance and capacitance in the circuit.

With the values shown, the output frequency is F = 1/2.2RC, where R = 10kΩ, and C = 1000pF, and the frequency is 45,454Hz or 45.454kHz.

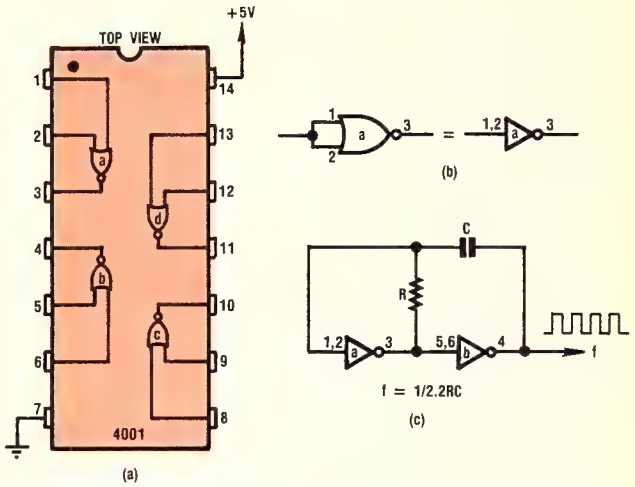


Fig.12: a CMOS 2-input quad NOR integrated circuit is shown in (a). With the two inputs tied together (b) the gate becomes a simple inverter that can be used for the pulse generator shown in (c). The numbers indicate the pin termination in (a).

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Noisy transformer in amplifier

I have recently completed an amplifier kit whose design I am sure you are familiar with. Unfortunately, the substituted dual C-core transformer radiates a magnetic field which I presume is responsible for an audible hum through the loudspeakers, slightly louder on the left than on the right, and constant regardless of advancing the volume, treble or bass controls.

The hum is present with and without inputs plugged in. Is there a safe way of shielding the transformer and would this be responsible for the noise? (G.M., Maroubra 2035).

● We know of only one amplifier currently being supplied with a C-core transformer. Strictly speaking though, it has only one core which consists of two C-cores held together by a Utilux hose clamp. The transformer in question should be very quiet and it is highly likely that it is not at fault at all.

The most common problem in today's low noise amplifier designs is earth loops. There should be only one connection from the amplifier circuit to the chassis. If there is an additional earth connection which may be caused by a short from the outer connection of the RCA phono socket to the chassis, there will be a constant low level hum which is independent of control settings.

Apart from a careful visual inspection, the way to check for the presence of an earth loop is to disconnect the main earth from the amplifier circuitry to its chassis. Then switch your multimeter to a low Ohms range and check for continuity between the amplifier circuit and chassis. There should be none. From then on it is a matter of visual detective work to see where the short is occurring.

If the above checks still bring no joy and the amplifier still hums, you can still check whether the transformer is the cause. All you have to do is to remove the transformer from the chassis while still leaving it connected. You may have to extend some of the leads to enable the transformer to be positioned outside the chassis.

Now turn on the power and listen carefully to the hum to see if it varies with orientation of the transformer. You may find that there is a null in the hum output with the transformer mounted at right angles to its present orientation.

As far as your question about shielding is concerned, it would be difficult to shield the whole transformer. However, it might be practical to install a copper strap over the winding assembly to reduce any stray leakage flux.

Once again though, we don't think the transformer would be the problem. We suspect an earth loop.

Wants timer with remote display

I hope you can help me with my problem. I am attempting this project for a local sporting club. It revolves around a three-decade programmable timer. I am fairly confident I can design the timer myself but I also need a remote display some 30 to 40 metres away from the counter itself.

How do I keep the cable stranding to a minimum? What problems will affect the digital signal over such a long run? Should I have a separate 5V supply at the remote display? What is the cheapest and simplest way?

I have tried to find books and articles on the subject of data transmission but most of it applies to computers and such with transmission distances of no more than 5 to 10 metres. I thought of trying multiplexers, D-A and A-D converters or maybe UARTs. I hope you can help me. (R.O'G., Rockhampton, Qld).

● Had you asked about a 3-digit timer without the need for presetting we would have said that it would be easier to have an additional remote timer so that only three leads would be necessary in the long cable; ie, + 5V, clock signal and 0V.

Since you need presettable counters (this letter was accompanied by a suggested schematic involving three 4029s, three 4511s

Wants Leak circuit diagram

Some time ago, I was given some quality valve audio equipment. It was being taken to the local tip and a friend thought it may be of interest. It turned out to be a Leak amplifier. So now I am the proud owner of a Leak "Stereo 20" plus the "Varislope Stereo" preamplifier to go with it. As it turned out, replacing the various coupling and filter capacitors gave me a perfectly functional unit.

This brings me to my problem. I am trying to find a source of the circuit information on this equipment, particularly of the preamplifier. Could you suggest anyone with this information? I know the gear was imported into Australia from England around 1960 by Simon Gray Pty Ltd. However the company doesn't exist any longer. (J.Sweet, 91 Anne Street, Aitkenvale, Qld 4814).

● Alas, we know of no source of the circuit information you require. We have printed your name and address in the hope that one of our readers can help you.

Ribbon or coax: which is best?

All of the information I have read about UHF antennas in Australia recommends the use of 75-ohm coax cable and most of the installations I have seen in this country have used coax. But I have been overseas to the US and Japan on a number of occasions and there they seem to use ribbon cable frequently. Why is that? Why is there such a preference in Australia for coax? I can't believe that our reception conditions for UHF would be any more difficult than in cities in Japan and the US.

● We doubt whether UHF reception conditions are any more difficult in Australian cities than overseas. Based on typical attenuations figures at UHF for ribbon cable and coax cable, you might think that ribbon would be the more desirable. After all, most coax cables have losses of 10dB/30m or more at UHF which is considerably more than the nominal losses of ladder-type ribbon cable but we would not recommend ribbon cable on that basis.

It is possible that in some situations, 300-ohm ribbon cable might give comparable reception quality to 75-ohm coax but you could only justify its use in areas away from the sea which don't have high rainfall. Once ribbon cable becomes wet or coated with a salt film, it starts to produce much higher losses.

It deteriorates quickly too and is subject to signal pickup on the cable itself, producing leading ghosts and smeary pictures.

As far as we are aware, coax cable is universally used throughout Europe for UHF reception and the same can now be said for the USA and Japan. It is also true that many if not most installations in apartment buildings overeases would not feed UHF signals via distribution system to each tenant. The signal losses, particularly in older installations using inferior cables, would make it impractical.

Rather, it is standard practice to feed the UHF signals to a down-converter so that the signals are distributed at VHF.

The message is: forget ribbon for UHF. If coax cable losses are likely to be a problem, you should use a masthead amplifier to boost the signal before it is distributed.

and three 7-segment displays), you will need to run 12 separate data lines plus the supply lines. That makes it messy.

We don't think UARTs (Universal Asynchronous Receiver/Transmitter) would be practical or cheap since you would need two 8-bit UARTs to send and another two to receive, plus all the timing circuitry required.

Nor would A-D and D-A conversion be practical or cheap because that also implies quite a lot of supporting circuitry.

The only practical way seems to be to send all 12 data lines via RS232 receivers and transmitters. We suggest you use the Motorola MC1488 quad line driver and MC1489 quad line receivers, both of which are quite cheap. You would need three to transmit and three to receive. You will also need ± 12V supplies for the transmitters in addition to 5V for the remote display.

We admit that our suggested solution does not look simple, but it is probably the cheapest way.

Corrections

Digital Fundamentals, Dec. 1987: Fig.6 on page 92 has been reproduced incorrectly. The type down the left-hand edge of the diagram should read INPUT A, INPUT B, INPUT C and OUTPUT D. In addition, the second last paragraph on page 92 should read as follows: At times t_1 through t_8 the three inputs are never high at the same time. However, beginning at time t_8 and ending at time t_9 the three inputs are all high so that output D goes high.

Subcarrier Adaptor

continued from page 67

setting up procedure is relatively simple.

First, make sure that VR1 is set so that its wiper is turned toward the LM565. This will provide maximum signal level. Now adjust VR2 so that there is audio signal. Find the extreme settings of VR2 where the audio signal drops out, then set VR2 halfway between the two extremes.

VR1 is used to minimise noise from the audio signal when the FM signal level is poor. Adjust the trimmer until the sound becomes distorted and then back off the adjustment until distortion is no longer audible. If you have a strong FM signal, adjustment of VR1 will have no effect on the noise level and so it should be left at its maximum resistance setting.

UHF Antenna

continued from page 21

enable you to terminate cables from your VHF and UHF antennas. A single cable goes from the diplexer to your TV set. Alternatively, the diplexer output may be fed to a splitter and then to various TV wall plates around your home.

Tune your TV to the local UHF station(s) and then orient the antenna for best reception.

Secure the cable to the mast with plastic cable ties to prevent the cable from flapping in the wind. Seal the balun box with silicone sealant to weatherproof it.

Painting

Depending on where you live, painting the antenna can be worthwhile, particularly in seaside areas or near industrial areas where there may be a lot of fallout. In these cases, we suggest painting the antenna with an etch primer and then finishing with an aluminium loaded paint such as British Paints "Silvar".

As a final comment, if you are building the antenna to receive stations right at the top of band V, say between channels 59 and 69, a small improvement can be gained by shortening the dipole elements by 5%.

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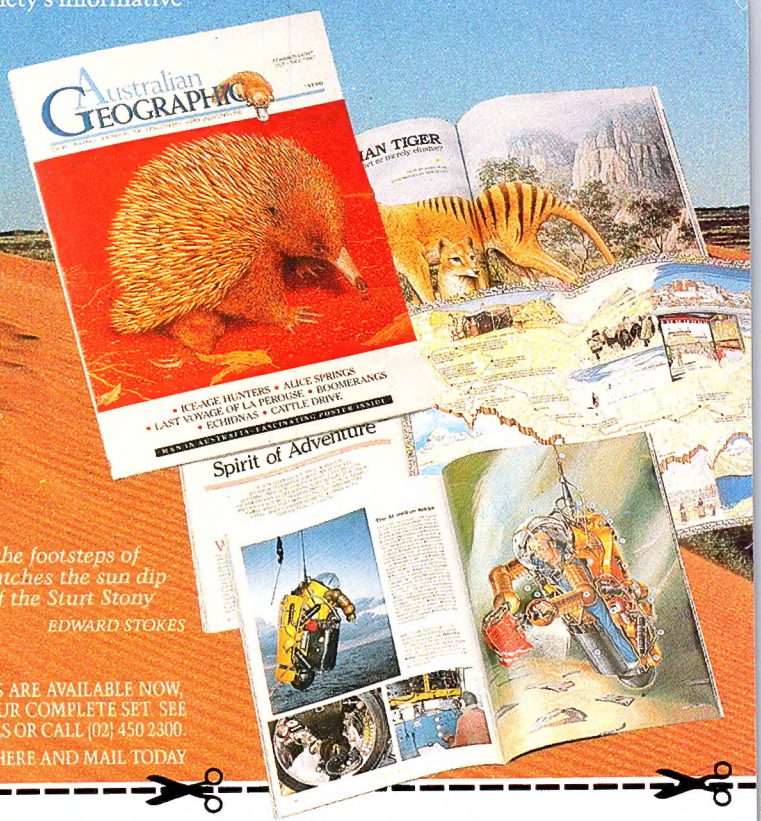
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